(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2002－191580
（P2002－191580A）
(43)公開日　平成14年７月９日(2002.7.9)

(51)Int.Cl.[7]	識別記号	FI		テーマコード（参考）
Ａ６１Ｂ　5/11		Ｇ０１Ｃ　22/00	Ｅ	２Ｆ０２４
Ｇ０１Ｃ　22/00			Ｗ	４Ｃ０３８
		Ｇ０６Ｍ　7/00	Ｊ	
Ｇ０６Ｍ　7/00		Ａ６１Ｂ　5/10	３１０Ａ	

審査請求　有　　請求項の数６　ＯＬ　（全 20 頁）

(21)出願番号　特願2001－102035(P2001－102035)
(22)出願日　平成13年３月30日(2001.3.30)
(31)優先権主張番号　特願2000－315654(P2000－315654)
(32)優先日　平成12年10月16日(2000.10.16)
(33)優先権主張国　日本（ＪＰ）

(71)出願人　000002945
オムロン株式会社
京都市下京区塩小路通堀川東入南不動堂町801番地
(72)発明者　久保　誠雄
京都府京都市下京区塩小路通堀川東入南不動堂町801番地　株式会社オムロンライフサイエンス研究所内
(74)代理人　100085006
弁理士　世良　和信　（外１名）

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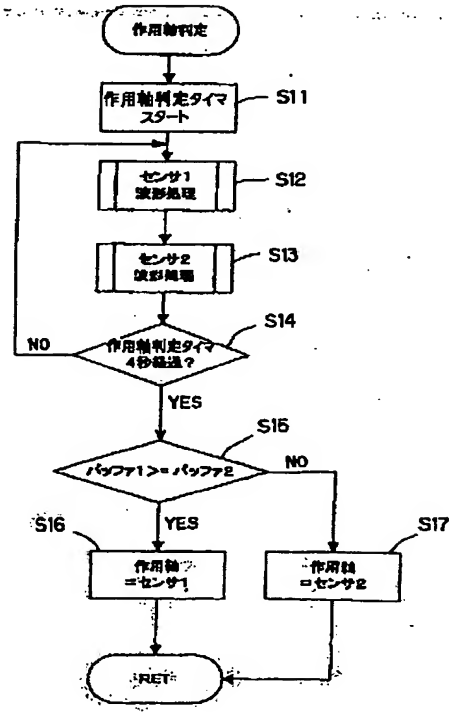
(54)【発明の名称】体動検出装置

(57)【要約】
【課題】　自由に装着，携帯可能な体動検出装置で、装置の姿勢にかかわらず高い精度の検出可能、低コストかつコンパクトな体動検出装置を提供する。
【解決手段】　検出する体動方向が異なる２つの体動センサを有する体動検出装置において、体動を検出する際には、体動センサ１及び２の波形処理を行い（ステップ１２，１３）、所定時間経過後、バッファ１に格納されている体動センサ１の出力信号から得られた加速度波形の数が、バッファ２に格納されている体動センサ１の出力信号から得られた加速度波形の数より大きいか等しければ（ステップ１５）、体動センサ１を作用軸として選択し（ステップ１６）、そうでなければ、体動センサ２を作用軸として選択し（ステップ１７）、作用軸として選択された体動センサの出力信号に基づいて、体動を検出する。



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【特許請求の範囲】

【請求項１】　使用者が自由に携帯又は装着して体動を検出する装置であって、

それぞれ検出する体動方向が異なるように配置され、体動に応じた信号を出力する複数の体動センサと、

前記複数の体動センサのうち、いずれの体動センサからの出力信号を体動検出の対象とするかを、前記複数の体動センサからの出力信号に対する演算処理により選択するセンサ選択手段と、

を備えたことを特徴とする体動検出装置。

【請求項２】　前記センサ選択手段は、

前記体動センサからの出力信号波形を解析する信号波形解析手段を含むことを特徴とする請求項１記載の体動検出装置。

【請求項３】　前記信号波形解析手段は、一定時間内に得られた所定条件を満たす信号波形の数の計数，信号波形の大きさの算出，信号波形の周波数解析及び信号波形のパターン解析の少なくともいずれかを行うことを特徴とする請求項２記載の体動検出装置。

【請求項４】　前記体動センサは、体動によって生じる加速度に応じて変化する信号を出力することを特徴とする請求項１乃至３のいずれかに記載の体動検出装置。

【請求項５】　前記体動センサによって検出される体動は、歩行及び走行の少なくともいずれかを含むことを特徴とする請求項１乃至４のいずれかに記載の体動検出装置。

【請求項６】　使用者が自由に携帯又は装着して体動を検出する装置であって、

それぞれ検出する体動方向が異なるように配置され、体動に応じた信号を出力する複数の体動センサと、

前記複数の体動センサの出力信号に基づいて前記装置の姿勢を判定する姿勢判定手段と、

前記複数の体動センサの出力信号に対して、前記姿勢判定手段によって判定された前記装置の姿勢に応じた演算処理を行うことにより使用者の体動を検出する体動検出手段と、

を備えたことを特徴とする体動検出装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、体動に応じた信号を出力するセンサを複数設けた場合に、複数のセンサの中から測定に適したセンサを選択して測定を行う体動検出装置に関する。

【０００２】

【従来の技術】従来、複数のセンサから本測定の対象とする出力信号（又はセンサ）を選択する体動検出装置としては、例えば、特開平９－２２３２１４号に記載された歩数計のように、複数センサの出力信号を、例えば光学センサのようなメカ式の角度検出センサの出力信号に基づいて、複数センサの出力信号のうちの一つを選択するものがある。

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【０００３】また、予め装置の装着方向が既知である場合に複数のセンサから本測定の対象とするセンサを選択する体動検出装置が、特開平１１－４２２２０号に記載されている。

【０００４】また、予め定められた方向及び位置に固定して使用する体動検出装置として、２軸又は３軸の加速度センサを用いて体動を計測し、平地歩行，階段上り，階段下り等の歩行形態を識別する加速度計が第１１回生体・生理工学シンポジウム論文集ＢＰＥＳ´９６ｐ．ｐ４９３～４９６に開示されている。この報告には、３軸の加速度センサを対象者の腰部に固定装着して歩いたときに得られる加速度波形を解析し、歩行形態を識別しており、加速度計は腰部に傾かないように固定装着しておく必要がある。

【０００５】

【発明が解決しようとする課題】しかしながら、角度検出センサ等のメカ式の検出部を設けて出力信号を選択する場合には、別途、角度検出センサを設ける必要があり、コストが高くなるとともに、角度検出センサの設置スペース分だけ装置が大きくなるという問題があった。

【０００６】また、装置の装着方向が決められている場合には、装置の方向を固定して使用しなければならず、装着できる場合が限られてしまう。さらに、装置の装着位置も制限され、装着方向を誤ると正しい測定結果が得られない等の問題があった。

【０００７】本発明は、かかる従来技術の課題を解決するために、使用者が自由に装着又は携帯し得る体動検出装置において、装置の姿勢にかかわらず高い精度で体動を検出でき、低コストかつコンパクトに構成し得る体動検出装置を提供することにある。

【０００８】

【課題を解決するための手段】上記目的を達成するために、本発明は、使用者が自由に携帯又は装着して体動を検出する装置であって、それぞれ検出する体動方向が異なるように配置され、体動に応じた信号を出力する複数の体動センサと、前記複数の体動センサのうち、いずれの体動センサからの出力信号を体動検出の対象とするかを、前記複数の体動センサからの出力信号に対する演算処理により選択するセンサ選択手段と、を備えたことを特徴とする体動検出装置である。

【０００９】このようにすれば、使用者が自由に携帯又は装着し得る体動検出装置において、装置の姿勢にかかわらず、常に体動検出に適した体動センサを選択して、そのセンサの出力信号に基づいて体動を検出することができるので、高い精度で体動を検出できる。また、複数の体動センサの出力信号に対する演算処理により、体動検出に適した体動センサを選択するので、角度センサ等のような手段を別途設ける必要がなく、低コストかつコンパクトに構成し得る体動検出装置を提供することがで

きる。

【００１０】また、前記センサ選択手段は、前記体動センサからの出力信号波形を解析する信号波形解析手段を含むことが好適である。

【００１１】また、前記信号波形解析手段は、一定時間内に得られた所定条件を満たす信号波形の数の計数，信号波形の大きさの算出，信号波形の周波数解析及び信号波形のパターン解析の少なくともいずれかを行うようにしてもよい。

【００１２】また、前記体動センサは、体動によって生じる加速度に応じて変化する信号を出力することが好適である。

【００１３】また、前記体動センサによって検出される体動は、歩行及び走行の少なくともいずれかを含むことが好適である。

【００１４】また、本発明は、使用者が自由に携帯又は装着して体動を検出する装置であって、それぞれ検出する体動方向が異なるように配置され、体動に応じた信号を出力する複数の体動センサと、前記複数の体動センサの出力信号に基づいて前記装置の姿勢を判定する姿勢判定手段と、前記複数の体動センサの出力信号に対して、前記姿勢判定手段によって判定された前記装置の姿勢に応じた演算処理を行うことにより使用者の体動を検出する体動検出手段と、を備えたことを特徴とする。

【００１５】このようにすれば、使用者が自由に携帯又は装着して、歩行形態の識別等の体動を検出することができるので、使用者の自由度が広がる。

【００１６】

【発明の実施の形態】以下、本発明を図示の実施形態に基づいて説明する。

【００１７】（第１の実施形態）図１は本発明の実施形態に係る体動検出装置としての歩数計を示す外観斜視図であり、図２は同平面図である。

【００１８】歩数計１０は、扁平な立体形状であり、側面が楕円形の長辺の一端部を取り除いた形状をなしている。また、楕円形の長辺の他端部には、紐等を挿通する孔を有する紐支持部１０ａが突出形成されている。ケース１の表面には、ＬＣＤ等からなる表示画面２，設定スイッチ３，メモリ／△スイッチ４，表示切換スイッチ５及びリセットスイッチ６が設けられている。ケース１の裏面には、電池カバー７及びシステムリセットスイッチ８が設けられている。

【００１９】歩数計には、一般的に推奨される姿勢があり、例えば、ベルトやスラックス，スカート，パンツ等の腰部にクリップで確実に装着するというように取扱説明書等によって装着位置の指定がなされる。一方、ポケットの中に入れたり、首からぶらさげたり、あるいは、かばんの中に入れている場合などのように常に推奨される姿勢で歩数計を保持されるとは限らない場合でも、本歩数計１０では高精度の計数が可能である。

【００２０】図３は歩数計のケース１内部の体動センサの配置を模式的に示したものである（但し、回路基板等のケース内の他の構成は省略している。）。

【００２１】本実施形態で用いる体動センサは、体動によって生じる加速度に応じて変化する信号を出力する加速度センサである。体動センサ１１（他の体動センサ１２等も同様である）は、板状の支持体１１ａと、支持体端部に設けられた重り１１ｂと、支持体面上に形成された圧電素子からなる検知部１１ｃとを含み、体動に起因して重りに作用する加速度によって生じる支持体１１ａの変形（歪み）を圧電素子１１ｃの電圧信号に変換して取り出す。

【００２２】図３（ａ）では、体動センサ１１，１２は、互いに直交するＸＹ方向に配置されている。図３（ｂ）のように３個以上の体動センサを配置してもよい。図３（ｂ）では、互いに直交するＸＹ方向の体動センサ１１１，１１２に加えて、ＸＹ方向に挟まれる約４５°の方向に一つの体動センサ１１３，さらに、３つの体動センサ１１１，１１２，１１３が配置された平面に直交するＺ方向の体動を検出する体動センサ１１４が配置されている。ＸＹ方向に挟まれた約４５°の角度の体動については、体動センサ１１１，１１２のいずれの出力も小さくなるので、このような場合には体動センサ１１３が有効である。

【００２３】図４は歩数計１０の内部構成を示すブロック図である。

【００２４】歩数計１０は、主として、互いに直交するＸＹ方向に配置された体動検出用の体動センサ１１，１２と、体動センサ１１，１２の出力電圧を増幅する増幅回路１３，１４と、電池１９と、時刻・歩数・連続歩数・連続歩行時間・消費カロリーを表示するＬＣＤ２と、設定スイッチ３等の操作スイッチ１７と、システムリセットスイッチ８と、ＬＣＤ表示制御，操作スイッチ入力検知，シーケンス制御及び電源供給等を制御する演算回路１５からなる。

【００２５】体動センサ１１，１２から得られた信号は、作用軸判定部２１に入力される。作用軸判定部２１において作用軸が選択され、選択された作用軸の信号を用いて歩数カウンタ２３で歩数をカウントする。

【００２６】図５は、図３（ｂ）に示したように４つの体動センサを有する歩数計のブロック図である。増幅回路が各体動センサごとに計４つ設けられている点を除いて図４に示す歩数計と同様の構成を有するので詳細な説明は省略する。本発明に係る体動検出装置では、体動センサの個数は上述のものに限られるものではない。

【００２７】（歩数計数処理）つぎに、歩数計を用いた歩数計数処理について説明する。

【００２８】図６は歩数計における歩数計数処理のメインルーチンの処理手順を示すフローチャートである。

【００２９】まず、体動センサからの出力信号の入力に

よって処理が開始される。

【００３０】作用軸判定部に入力された複数の体動センサに接続された増幅回路からの出力に基づいて作用軸判定処理が行われる（ステップ１）。作用軸の判定処理によって特定の作用軸に固定される（ステップ２）。次に、固定された作用軸に対応する体動センサからの出力データをバッファから歩数カウンタに送り、歩数を計数する（ステップ３）。これに伴ってバッファのデータを消去する（ステップ４）。次に、歩数カウンタによって計数された歩数をＬＣＤに表示する（ステップ５）。このとき、ＬＣＤに表示されるのは、上述の作用軸に対応する体動センサによって検出された歩行の歩数である。次に、一歩の波形が入力されたか否かを判定する（ステップ６）。一歩の波形が入力されるまでステップ６を繰り返し、一歩の波形が入力されると、２秒以内に入力されたか否かを判定する（ステップ７）。２秒以内であれば、歩数カウンタのカウントを＋１して（ステップ８）、ステップ５に戻る。２秒以内でなければ、ステップ１に戻る。

【００３１】（作用軸判定処理）まず、体動センサを加速度センサによって構成し、歩行時に得られた加速度波形の解析として一定時間内に得られた加速度波形の数を用いて作用軸判定処理を行う場合について説明する。

【００３２】図７は作用軸判定処理の手順を示すフローチャートである。

【００３３】まず、作用軸判定タイマをスタートする（ステップ１１）。

【００３４】次に、体動センサ１の波形処理を行い（ステップ１２）、体動センサ２の波形処理を行う（ステップ１３）。

【００３５】ここで、体動センサ１及び体動センサ２によって得られる加速度波形の例を図８に示す。図８では横軸が時間（右方が時間の進む向き）であり、縦軸が加速度である（例えば電圧によって表されされていてもよい。）。

【００３６】次に、作用軸判定タイマの計時が４秒を経過しているか否かを判定する（ステップ１４）。４秒を経過していなければステップ１２に戻る。４秒経過していれば、バッファ１に格納されている体動センサ１の出力信号から得られた加速度波形の数、例えば、歩行時に得られた加速度波形の数（フローチャートではこれを「バッファ１」と略記している。）が、バッファ２に格納されている体動センサ２の出力信号から得られた加速度波形の数（フローチャートではこれを「バッファ２」と略記している。）より大きい又は等しいという関係にあるか否かを判定する（ステップ１５）。バッファ１に格納されている体動センサ１の出力信号から得られた加速度波形の数がバッファ２に格納されている体動センサ２の出力信号から得られた加速度波形の数より大きい又は等しいという関係が成り立つ場合には、体動センサ１を作用軸として選択し（ステップ１６）、作用軸判定処理を終了する。バッファ１に格納されている体動センサ１の出力信号から得られた加速度波形の数がバッファ２に格納されている体動センサ２の出力信号から得られた加速度波形の数より大きい又は等しいという関係が成り立たない場合には、体動センサ２を作用軸として選択し（ステップ１７）、作用軸判定処理を終了する。すなわち、加速度波形の数の多い方が作用軸として選択される。

【００３７】（波形処理）図９（ａ）は体動センサ１の波形処理の手順を示すフローチャートである。

【００３８】体動センサ１の出力信号から得られた加速度波形が、上閾値を既に超えているか否かをフラグ（Thu1）によって判定する（ステップ２１）。Thu1＝０であれば、上閾値を超えるまで判定が繰り返され（ステップ２２）、上閾値を超えたらフラグ（Thu1）を１とし（ステップ２３）、下閾値の判定に進む。一方、Thu1＝１であれば、下閾値の判定に進む。ここで、体動センサ１の出力信号から得られた加速度波形が下閾値を超えたか否かの判定は、加速度波形が下閾値を超えるまで繰り返され（ステップ２４）、下閾値を超えたら加速度波形が１波形目か否かを判定する（ステップ２５）。例えば、歩行時に得られた加速度波形であれば、１波形目は無条件にバッファに格納された値に１が加算され（ステップ２７）、２波形目以降であれば、１波形前との間隔が規定間隔内（Ts規定値min≦ TsかつTs≦ Ts規定値max）であるか否かを判定し（ステップ２６）、規定間隔内であれば、バッファに格納された値に１が加算される（ステップ２７）。その後、フラグを（Thu1）＝０とし（ステップ２８）、軸判定タイマが４秒経過するまで繰り返される。図８（ｂ）は体動センサ２の波形処理の手順を示すフローチャートであるが、処理の詳細は図８（ａ）と同様であるので説明は省略する。ステップ２６で行う判定は、体動センサの出力信号から歩行による信号以外の信号を排除する趣旨である。

【００３９】このようにメカ式の角度センサ等の装置の姿勢検出手段を別途設けることなく、ソフト的に適切な体動センサの出力を取り出して、歩数等の計数を行うので、姿勢検出手段のためのスペースやコストが不要となる。従って、低コストかつコンパクトな歩数計を構成することができる。

【００４０】尚、本実施形態では、体動検出装置として、歩数計についてのみ説明しているが、体動を検出し利用する装置であればよく、歩数以外の指標に変換するものも当然に含まれる。

【００４１】（第２の実施形態）以下、本発明の第２の実施形態について説明する。歩数計の内部構成及び歩数計数処理については、第１の実施形態と同様であるので、異なる部分についてのみ説明する。

【００４２】本実施形態では、歩行時に得られた加速度

波形の解析として加速度波形のパワー値を用いて作用軸判定処理を行う。

【００４３】（作用軸判定）図１０は作用軸判定処理の手順を示すフローチャートである。

【００４４】ステップ４１～ステップ４４までの処理は、図７に示す加速度波形の数を用いる場合と同様であるので、説明を省略する。

【００４５】作用軸判定タイマが４秒経過した時点で、体動センサ１と体動センサ２から得られた加速度波形のパワー値（ｐ－ｐ値（所定区間内の加速度波形の極値間の代数差のうち最大値）の２乗によって定義される。）、例えば、４秒間に得られた波形のうちの最初の３波形のパワー値（（Ｐｐ）^{2}）の加算値（Ｐｐ（１）^{2}＋Ｐｐ（２）^{2}＋Ｐｐ（３）^{2}）（図９では、Ｐｐ１，Ｐｐ２と表記）を比較する（ステップ４５）。比較の結果、パワー値の加算値の大きい方を作用軸として選択する（ステップ４６，４７）。また、ｐ－ｐの絶対値の大きさで比較しても良い。

【００４６】（波形処理）図１１（ａ）は、体動センサ１の波形処理の手順を示すフローチャートである。

【００４７】まず、体動センサ１の波形処理の手順を示すフローチャートである。

【００４８】体動センサ１の出力信号から得られた加速度波形が、上閾値を既に超えているか否かをフラグ（Thu1）によって判定する（ステップ５１）。Thu1＝０であれば、上閾値を超えるまで判定が繰り返され（ステップ５２）、上閾値を超えたらフラグ（Thu1）を１とし（ステップ５３）、１波形目か否かを判定する（ステップ５４）。ここで、１波形目であればステップ５９の下閾値の判定に進み、２波形目以降であれば、１波形前との間隔（Ts）が規定間隔内（Ts規定値min≦TsかつTs≦Ts規定値max）であるか否かを判定する（ステップ５５）。Tsが規定範囲内であれば、バッファに格納された値に１を加算し（ステップ５６）、加速度波形のパワー値（（Ｐｐ）^{2}）を算出し、前波形のパワー値に加算する（ステップ５７）。例えば、Ｐｐ１には４秒間に得られた最初の３波形のみ加算する（ステップ５７）。一方、ステップ５３においてThu1＝１である場合、あるいはステップ５４において１波形目である場合にも、パワー値を加算した場合と同様に下閾値の判定に進む。ここで、体動センサ１の出力信号から得られた加速度波形が下閾値を超えたか否かの判定は、加速度波形が下閾値を超えるまで繰り返され（ステップ５９）、下閾値を超えたらフラグを（Thu1）０とし（ステップ６０）、軸判定タイマが４秒経過するまで繰り返される。図１１（ｂ）は体動センサ２の波形処理の手順を示すフローチャートであるが、処理の詳細は図１１（ａ）と同様であるので説明は省略する。

【００４９】上述の処理では、パワー値の加算を４秒間に得られた最初の３波形の加算値としたが、２波形でも、３波形以上でもよい。また、１波形目から使用しなくてもよい。

【００５０】（第３の実施形態）以下、本発明の第３の実施形態について説明する。歩数計の内部構成及び歩数計数処理については、第１の実施形態と同様であるので、異なる部分についてのみ説明する。

【００５１】本実施形態では、歩行時に得られた加速度波形の解析として加速度波形の周波数解析を用いて作用軸判定処理を行う。

【００５２】（作用軸判定処理）図１２は、作用軸判定処理の手順を示すフローチャートである。

【００５３】まず、作用軸判定タイマをスタートする（ステップ７１）。

【００５４】次に、体動センサ１によって得られる加速度波形をフーリエ変換し（ステップ７２）、体動センサ２によって得られる加速度波形をフーリエ変換する（ステップ７３）。

【００５５】図１３（ａ），（ｂ）にそれぞれ体動センサ１，体動センサ２によって得られる加速度波形をフーリエ変換して得られる周波数分布の例を示す。図１３（ａ）に示すように体動センサ１の加速度波形の周波数分布はきわめてばらつきがすくなく、例えば２Ｈｚの位置（Ｆ１）に高いピーク（高さＦ１max）が見られる。図１３（ｂ）に示すように体動センサ２の加速度波形の周波数分布はばらついており２．１Ｈｚの位置（Ｆ２）に低いピーク（高さＦ２max）があり、他の周波数にもより低いピークが存在する。この例は、体動センサ１方向では検出すべき体動による加速度変化が検出されており、体動センサ２方向では検出すべき体動とは異なる不要な振動を含む信号が検出されている状態を示す。

【００５６】次に、作用軸判定タイマが、例えば、４秒経過したか否かを判定し（ステップ７４）、４秒を経過するまでステップ７２，７３を繰り返す。

【００５７】作用軸判定タイマの計時が４秒を経過した時点で、体動センサ１から得られた加速度波形の解析結果、最大ピークをもつ周波数（Ｆ１）及び最大ピークの値（Ｆ１max＝パワー値の最大ピーク値）を検出する（ステップ７５，７６）。次に、Ｆ１が規定周波数範囲内か否かを判定し（ステップ７７）、規定周波数範囲外であればＦ１maxをゼロクリアさせる（ステップ７８）。ここでは、例えば規定周波数を１Ｈｚ～３Ｈｚとしている。同様に体動センサ２から得られた加速度波形の解析結果、最大ピークをもつ周波数（Ｆ２）及び最大ピークの値（Ｆ２max＝パワー値の最大ピーク値）を検出し（ステップ７９，８０）、Ｆ２が規定周波数範囲内か否かを判定する（ステップ８１）。Ｆ２が規定周波数範囲内であれば、Ｆ１maxが０か否かを判定する（ステップ８２）。このとき、Ｆ１maxが０ならば作用軸として体動センサ２を選択する（ステップ８５）。一方、Ｆ１maxが０でなければ、Ｆ１max≧Ｆ２maxか否かを判定

する（ステップ８３）。ここで、Ｆ１max≧Ｆ２maxならば、作用軸として体動センサ１を選択する（ステップ８４）。また、ステップ８１でＦ２が規定周波数範囲外であればＦ１maxが０か否かを判定する（ステップ８６）。ここで、Ｆ１max＝０でなければ作用軸として体動センサ１を選択する（ステップ８４）。Ｆ１max＝０であれば軸判定タイマをゼロクリアし（ステップ８７）、ステップ７１に戻って再度作用軸判定を行う。

【００５８】（第４の実施形態）以下、本発明の第４の実施形態について説明する。歩数計の内部構成及び歩数計数処理については、第１の実施形態と同様であるので、異なる部分についてのみ説明する。

【００５９】本実施形態では、歩行時に得られた加速度波形の解析として加速度波形のパターン解析を用い作用軸判定処理を行う。

【００６０】（作用軸判定処理）図１４は作用軸判定処理の手順を示すフローチャートである。

【００６１】まず、作用軸判定タイマをスタートする（ステップ９１）。次に、体動センサ１及び体動センサ２から得られた加速度波形を基準波形と比較する（ステップ９２，９３）。例えば、基準波形は予め収集したデータから求めておき、測定時に検出された波形と比較する。作用軸判定タイマが、例えば、５秒経過するまでステップ９２，９３を繰り返す（ステップ９４）。作用軸判定タイマの計時が５秒経過したら、５秒間に得られた加速度波形のパターン解析結果によって作用軸を選択する。ここでは、基準波形との誤差が体動センサ１からの加速度波形の方が大きいか否かを判定する（ステップ９５）。基準波形との誤差が体動センサ１からの加速度波形の方が大きければ、作用軸として体動センサ２を選択し（ステップ９７）、基準波形との誤差が体動センサ１からの加速度波形の方が小さい又は等しければ、作用軸として体動センサ１を選択する（ステップ９６）。

【００６２】上述の加速度波形のパターン解析としては、例えば、加速度波形の波高値，波形の幅，ピーク間隔（周期），１波形における山や谷の数などを用いて予め求められた基準波形と比較してもいいし、前記パラメータを用いた検出波形の出現の安定性を用いてもよいし、クラスタ分析法等を用いた波形のパターン解析を用いてもよい。

【００６３】（第５の実施形態）第５の実施形態として、上記実施形態とは、異なる体動センサを有する体動検出装置としての歩数計について説明する。体動センサ以外の構成は第１乃至第４の実施形態と同様であるので、説明を省略する。

【００６４】図１５（ａ）は本実施形態に係る体動検出装置に用いる体動センサ１２０を示す。

【００６５】体動センサ１２０も、体動によって生じる加速度に応じて変化する信号を出力する加速度センサである。体動センサ１２０は、支点を中心として揺動し、先端に磁石１２０ｂが装着された振り子１２０ａと、振り子１２０ａの揺動範囲近傍の所定位置に設けられ、磁石１２０ｂの近接によりオンとなり、離間によってオフとなるリードスイッチ１２０ｃを含む。振り子の揺動範囲は不図示のストッパによって規制されている。また、振り子１２０ａはつるまきバネ等の付勢手段により揺動する振り子が所定位置に復帰するように構成されている。体動に起因して振り子に作用する加速度によって振り子１２０ａが揺動し、この振り子１２０ａの揺動を磁石１２０ｂの近接によるリードスイッチの１２０ｃ開閉によって生じる電圧又は電流の変化に変換して取り出している。

【００６６】体動センサ１２０の出力信号は図１５（ｂ）に示すようにパルス波形となる。パルス間間隔Ｔｓ（１）は図８に示す加速度波形と同様に定義されているが、ここではパルス幅がＰｐ（１）として定義されている。体動センサ１２０では、体動による加速度の大きさは振り子１２０ａの揺動角度が大きくなり、磁石１２０ｂがリードスイッチ１２０ｃに近接している時間が長くなるので、パルス幅が広くなる。このため、パルス幅をＰｐと定義している。

【００６７】第１の実施形態における作用軸判定処理は、加速度波形の数をパルス波形の数とすることにより本実施形態に係る体動センサにも適用することができる。

【００６８】また、第２の実施形態における作用軸判定は、上述のようにＰｐを定義することにより本実施形態に係る体動センサにも適用することができる。

【００６９】また、第３及び第４の実施形態における作用軸判定処理は、パルス波形でも同様の解析処理を行うことができるので、本実施形態に係る体動センサにも適用することができる。

【００７０】上述の体動センサ１２０は、磁石とリードセンサの組み合わせによって振り子の揺動を検出しているが、振り子の先端がフォトインタラプタを形成し、振り子の揺動により光路を断続するものでもよく、これらの構成に限られるものではない。

【００７１】（第６の実施形態）以下、本発明の第６の実施形態に係る体動検出装置について説明する。本実施形態に係る体動検出装置は、体動センサの出力によって、使用者によって自由に携帯又は装着された体動検出装置の姿勢を判断し、その姿勢に基づいて歩数の計数あるいは、これに加えて平地歩行，階段上り，階段下り等の歩行形態の識別を行う。

【００７２】まず、体動検出装置の姿勢を判断する原理について説明する。

【００７３】図１６において、第１の実施形態に係る歩数計に係る体動センサ１１と同様の構成を有する体動センサを用いて説明する。符号については体動センサ１１と同様の符号を用いる。体動センサ１１は、板状の支持

体１１ａの一方の面上に形成された圧電素子からなる検知部１１ｃと端部に形成された重り１１ｂとを備え、体動によって生じる加速度に応じて変化する信号を出力する加速度センサである。

【００７４】体動センサ１１の向きについて、図１６（ａ）に示すように検知部１１ｃが支持体１１ａの下面に位置する状態を第１の向き、図１６（ｂ）に示すように検知部１１ｃが支持体１１ａの上面に位置する状態を第２の向きと定義する。ここで、図１６（ａ），（ｂ）の体動センサ１１の右側に表示された波形は、矢印方向の運動が生じた場合に（体動センサの向きに拘わらず運動の向きは同じである。）、体動センサ１１からそれぞれ出力される加速度波形を示す。同じ運動が生じた場合でも、検知部１１ｃが支持体１１ａのいずれの面上に形成されているかに応じて、圧電素子に生じる変形の仕方が異なるので、出力される波形も異なる。従って、図１６（ａ）に示す第１の向きに配置された体動センサ１１から出力される加速度波形を正波形とすると、図１６（ｂ）に示す第２の向きに配置された体動センサ１１からは反転した加速度波形（逆波形）が出力される。

【００７５】従って、使用者又は空間に対して体動検出装置（又は体動センサ）が基準となる姿勢をとる場合の種々の運動による加速度波形のパターンを予め記憶しておけば、体動センサから出力される加速度波形のパターンと、基準姿勢時の加速度波形のパターンとを比較することにより、体動検出装置の姿勢を判断することが可能となる。すなわち、特別な姿勢判定のためのメカ的な装置を備えることなく、体動センサからの出力信号に対する演算処理によってソフト的に体動検出装置の姿勢を判断することができる。

【００７６】図１７に本実施形態に係る体動検出装置１００のブロック図を示す。第１の実施形態と同様の構成については同様の符号を用いて説明を省略する。

【００７７】本実施形態では、体動センサ１１１～１１４から得られた信号は姿勢判定部（姿勢判定手段）１２１に入力される。姿勢判定部１２１において体動検出装置１００の姿勢が判定され、判定された姿勢に基づいて歩行形態の識別等の演算処理が演算回路（体動検出手段）１５において行われる。本実施形態では、第１の実施形態と同様に作用軸判定部２１及び歩数カウンタ２３を備えているが、これらの構成を省略することもできる。

【００７８】（体動検出処理）図１８は体動検出装置１００における体動検出処理のメインルーチンの処理手順を示すフローチャートである。

【００７９】まず、体動センサ１１１～１１４からの出力信号の入力によって処理が開始される。

【００８０】姿勢判定部１２１に入力された複数の体動センサ１１１～１１４に接続された増幅回路からの出力に基づいて後述する姿勢判定処理が行われる（ステップ１０１）。

【００８１】次に、姿勢判定処理によって判定された体動検出装置１００の姿勢に基づいて体動検出処理が行われる（ステップ１０２）。ここで、体動検出処理としては、例えば、第１１回生体・生理工学シンポジウム論文集ＢＰＥＳ´９６ｐ．ｐ４９３～４９６第１の実施形態における歩行形態の識別処理を行うことができる。使用者が自由に携帯又は装着していても、姿勢判定処理によって使用者に対する体動検出装置１００の姿勢を特定することができるので、使用者又は空間に対して固定された３軸方向等のような所定方向の体動を検出し、歩行形態の識別を行うことができる。これに第１～第５の実施形態において説明した歩数の計数処理を組み合わせて各歩行形態での歩数を計数するようにすることもできる。

【００８２】（姿勢判定処理）次に、上述の姿勢判定処理のサブルーチンについて図１９に示すフローチャートに従って説明する。

【００８３】まず、各体動センサによって加速度を検出する（ステップ１１１）。

【００８４】次に、検出された加速度波形に対する加速度波形処理を行う（ステップ１１２）。

【００８５】次に、得られた加速度波形の向きが正波形か否かを判断する（ステップ１１３）。ここでは、体動センサが一つの場合について説明するが、複数の体動センサを備える場合も同様である。また、正波形とは、図１６（ａ）に示すように正方向に立ち上がる波形を指す。

【００８６】加速度波形の向きが正波形であれば、体動センサの向きは図１６（ａ）に示すような第１の向きであり（ステップ１１４）、一方、加速度波形の向きが正波形とは逆である場合には、体動センサの向きは図１６（ｂ）に示すような第２の向きであると判断する（ステップ１１５）。

【００８７】（３次元空間における体動検出装置の姿勢判定処理）本実施形態における体動検出装置１００の姿勢判定処理は上述した通りであるが、３次元空間における姿勢判定について、以下により詳細に説明する。

【００８８】体動検出装置には、互いに直交する方向の加速度を検出するために、３つの体動センサａ（１２２），体動センサｂ（１２３），体動センサｃ（１２４）が設けられている。体動センサａ（１２２），体動センサｂ（１２３），体動センサｃ（１２４）はいずれも第１の実施形態において説明した体動センサ１１と同様の構成を有する。図２０（ａ）に示すように体動センサａ（１２２），体動センサｂ（１２３），体動センサｃ（１２４）が配置された状態を基準姿勢とする。このとき、Ｘ，Ｙ，Ｚの３軸は、紙面（鉛直面）右方に延びるＸ軸，紙面上方に延びるＹ軸，紙面に直交方向の奥側から手前側に伸びるＺ軸として定義される。基準姿勢においては、センサａ（１２２）は重りが＋Ｘ方向となる

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ようにX軸に沿って配置され、センサb（１２３）は重りが＋Y方向となるようにY軸に沿って配置され、センサc（１２４）は重りが＋X方向と＋Y方向と４５度の角度をなす方向に向けて配置されている。この基準姿勢では、センサa（１２２）はY軸方向、センサb（１２３）はX軸方向、センサc（１２４）はZ軸方向の加速度をそれぞれ検出する。また、このときセンサa（１２２）の検知部は＋Y方向側に、センサb（１２３）の検知部は＋X方向側に、センサc（１２４）の検知部は＋Z方向側にそれぞれ配置されている。図３（a）又は（b）に示すような構成の体動検出装置であれば、直立した扁平な面がXY平面に平行となるように配置された状態を基準姿勢とすることができる。体動検出装置が基準姿勢である場合の体動センサの配置は、図２０（a）の場合に限られない。例えば、図２０（b）に示すように、センサa（１２２）を重りが＋X方向となるようにX軸に沿うとともに検知部が－Y方向側に位置するように配置し、センサb（１２３）を重りが－Y方向となるようにY軸に沿うとともに検知部が＋X方向側に位置するように配置し、センサc（１２４）を重りが－X方向と－Y方向と４５度の角度をなす方向であり、かつ検知部が－Z方向側に位置するように配置することもできる。また、図２０（c）に示すように、センサa（１２２）を重りが－Y方向となるようにY軸に沿うとともに検知部が＋X方向側に位置するように配置し、センサb（１２３）を重りが＋X方向となるようにX軸に沿うとともに検知部が－Y方向側に位置するように配置し、センサc（１２４）を重りが－X方向と－Y方向と４５度の角度をなす方向であり、かつ検知部が－Y方向に位置するように配置することもできる。

【００８９】図２１（a）は体動検出装置は体動検出装置が基準姿勢にある状態を示す。直方体は体動検出装置の姿勢を模式的に示す。このとき、体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）はそれぞれ図２０（a）に示すように配置されている。図２１（a）に示す基準姿勢となるように使用者に保持された状態で、使用者が所定の運動を行った場合の体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）から出力される加速度波形を図２１（b）に示す。

【００９０】使用者が体動検出装置を自由に装着又は携帯している状態で、体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）によって図２２（a）に示されるような加速度波形が出力された場合の姿勢判定処理について説明する。

【００９１】まず、体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）の出力に対するパターン解析として、図２２（a）の波形と図２１（b）の波形とのパターンマッチングを行う。図２２（a）に示されるセンサa（１２２）の加速度波形は図

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２１（b）に示されるセンサa（１２２）の加速度波形の逆パターンである。また、図２２（a）に示されるセンサb（１２３）の加速度波形は図２１（b）に示されるセンサb（１２３）の加速度波形と同様のパターンである。そして、図２２（a）に示されるセンサc（１２４）の加速度波形は図２１（b）に示されるセンサc（１２４）の加速度波形の逆パターンである。従って、体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）から出力される加速度波形に対するパターン解析から、図２２（a）に示す加速度波形が出力される場合の体動検出装置の姿勢は、図２１（a）に示す状態から、図２２（a）に示すようにX軸の回りに１８０度回転させた状態、すなわち、左右を保ったまま上下を裏返した状態となっていることが分かる。

【００９２】同様に、使用者が体動検出装置を自由に着又は携帯している状態で、体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）によって図２３（a）に示されるような加速度波形が出力された場合の姿勢判定処理について説明する。

【００９３】体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）の出力に対するパターン解析として、図２３（a）の波形と図２１（b）の波形とのパターンマッチングを行う。図２３（a）に示されるセンサa（１２２）の加速度波形は図２１（b）に示されるセンサb（１２３）の加速度波形と同様パターンである。また、図２３（a）に示されるセンサb（１２３）の加速度波形は図２１（b）に示されるセンサa（１２２）の加速度波形と逆パターンである。そして、図２３（a）に示されるセンサc（１２４）の加速度波形は図２１（b）に示されるセンサc（１２４）の加速度波形と同様のパターンである。従って、体動センサa（１２２），体動センサb（１２３），体動センサc（１２４）から出力される加速度波形に対するパターン解析から、図２３（a）に示す加速度波形が出力される場合の体動検出装置の姿勢は、図２１（a）に示す状態から、図２２（a）に示すようにZ軸の回りに－９０度回転させた状態、すなわち、右方向に９０度回転させて縦横を入れ替えた状態となっていることが分かる。

【００９４】このように、複数の体動センサの出力波形に対する演算処理によって体動検出装置の姿勢を判定することができ、特定された姿勢に応じて歩行態様等の体動検出処理を行うことができる。従って、使用者は所定の姿勢で装置を固定する必要がなく、自由に携帯又は装着した状態で体動検出を行うことができるので、使用者の自由度が広がる。

【００９５】

【発明の効果】以上、説明したように本発明によれば、使用者が自由に装着又は携帯し得る体動検出装置において、装置の姿勢にかかわらず、常に体動検出に適した体

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動センサを選択して、そのセンサの出力信号に基づいて体動を検出することができるので、高い精度で体動を検出できる。また、複数の体動センサの出力信号に対する演算処理により、体動検出に適した体動センサを選択するので、角度センサ等のような手段を別途設ける必要がなく、低コストかつコンパクトに構成し得る体動検出装置を提供することができる。また、体動検出のために、装置を所定の姿勢に固定して装着する必要がないので、使用者の自由度が広がる。

【図面の簡単な説明】

【図１】図１は本発明の実施形態に係る歩数計の外観斜視図である。

【図２】図２は本発明の実施形態に係る歩数計の平面図である。

【図３】図３は歩数計内の体動センサの配置を示す図である。

【図４】図４は歩数計の内部構成を示すブロック図である。

【図５】図５は他の歩数計のブロック図である。

【図６】図６は歩数計における歩数計数処理の手順を示すフローチャートである。

【図７】図７は作用軸判定処理の手順を示すフローチャートである。

【図８】図８は体動センサによって得られる加速度波形の例を示す図である。

【図９】図９は体動センサの波形処理を示すフローチャートである。

【図１０】図１０は作用軸判定処理の手順を示すフローチャートである。

【図１１】図１１は体動センサの他の波形処理を示すフローチャートである。

【図１２】図１２は他の作用軸判定処理の手順を示すフローチャートである。

【図１３】図１３は体動センサの加速度波形をフーリエ変換した結果を示す図である。

【図１４】図１４は他の作用軸判定処理の手順を示すフローチャートである。

【図１５】図１５（ａ）体動センサの構成を模式的に示

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したものである。図１５（ｂ）は体動センサの出力信号を示す図である。

【図１６】図１６（ａ），（ｂ）は体動検出装置の姿勢判定原理を説明する図である。

【図１７】図１７は本発明の第６の実施形態に係る体動検出装置の構成を示すブロック図である。

【図１８】図１８は本発明の第６の実施形態に係る体動検出装置における体動検出処理の主たる処理手順を示すフローチャートである。

【図１９】図１９は本発明の第６の実施形態に係る体動検出装置における姿勢判定処理の手順を示すフローチャートである。

【図２０】図２０（ａ），（ｂ），（ｃ）は３つの体動センサの配置例を示す図である。

【図２１】図２１（ａ）は基準姿勢にある体動検出装置を示す図であり、図２１（ｂ）は基準姿勢時の各体動センサからの出力波形を示すグラフである。

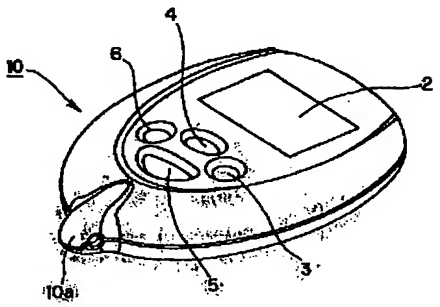
【図２２】図２２（ａ）は他の姿勢にある体動検出装置を示す図であり、図２２（ｂ）は他の姿勢時の各体動センサからの出力波形を示すグラフである。

【図２３】図２３（ａ）はさらに他の姿勢にある体動検出装置を示す図であり、図２３（ｂ）はさらに他の姿勢時の各体動センサからの出力波形を示すグラフである。

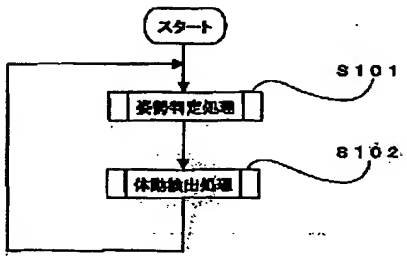
【符号の説明】

１　ケース
２　ＬＣＤ
３　設定スイッチ
４　メモリ／△スイッチ
５　表示切替スイッチ
６　リセットボタン
１０　歩数計
１１，１２　体動センサ
１１１，１１２，１１３，１１４　体動センサ
１００　体動検出装置
１２１　姿勢判定部
１２２　体動センサａ
１２３　体動センサｂ
１２４　体動センサｃ

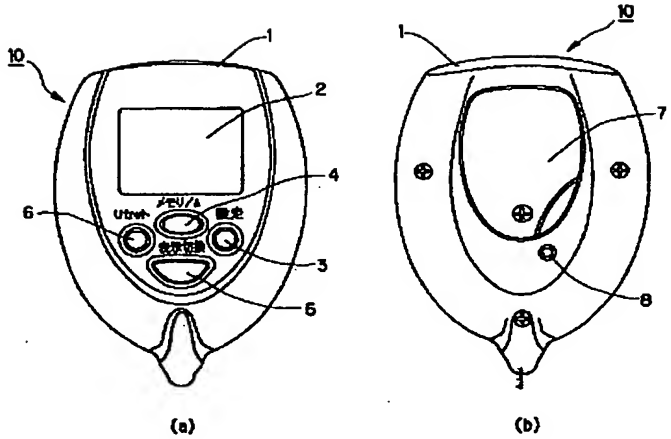
【図１】



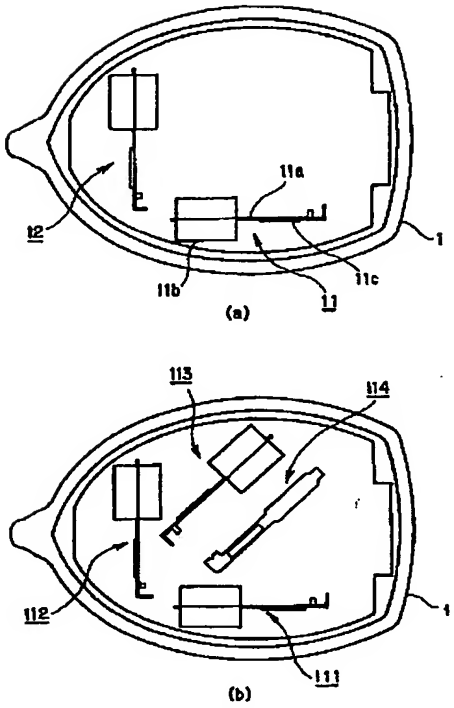
【図１８】



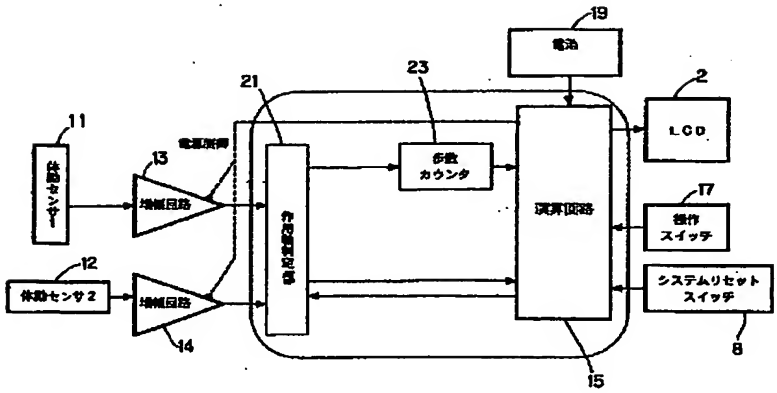
【図２】


10
1
2
4
6
3
5
(a)
10
1
7
8
(b)

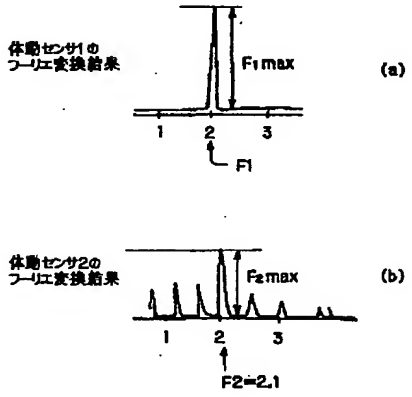
【図３】


11a
12
1
11b
11c
11
(a)
113
114
112
111
(b)

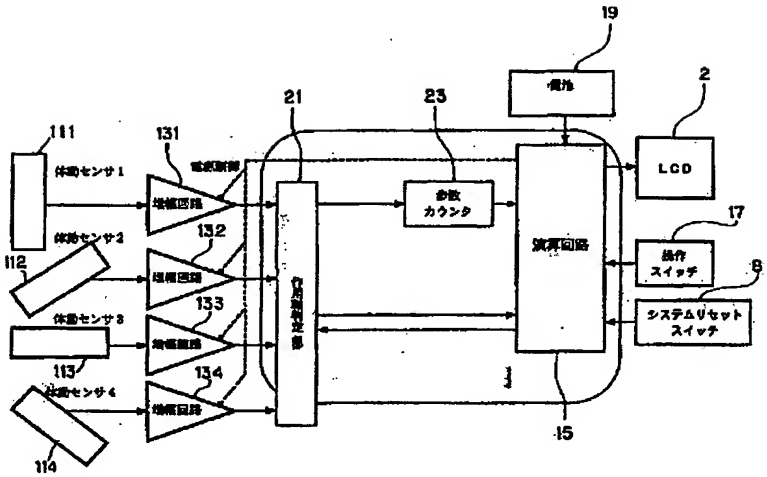
【図４】


19
電池
21
23
2
LCD
11
体動センサー
13
増幅回路
歩数カウンタ
演算回路
17
操作スイッチ
12
体動センサ２
増幅回路
14
システムリセットスイッチ
8
15

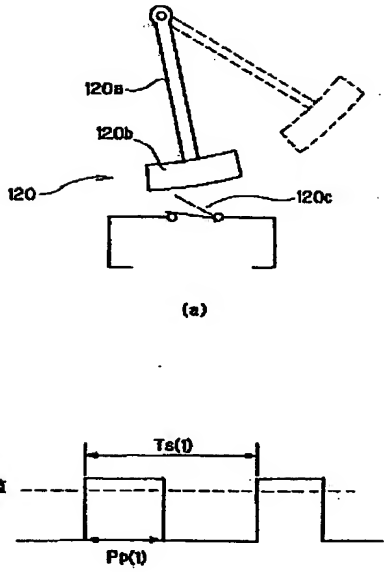
【図１３】


体動センサ1のフーリエ変換結果
F1max
(a)
1
2
3
F1
体動センサ2のフーリエ変換結果
F2max
(b)
1
2
3
F2=2.1

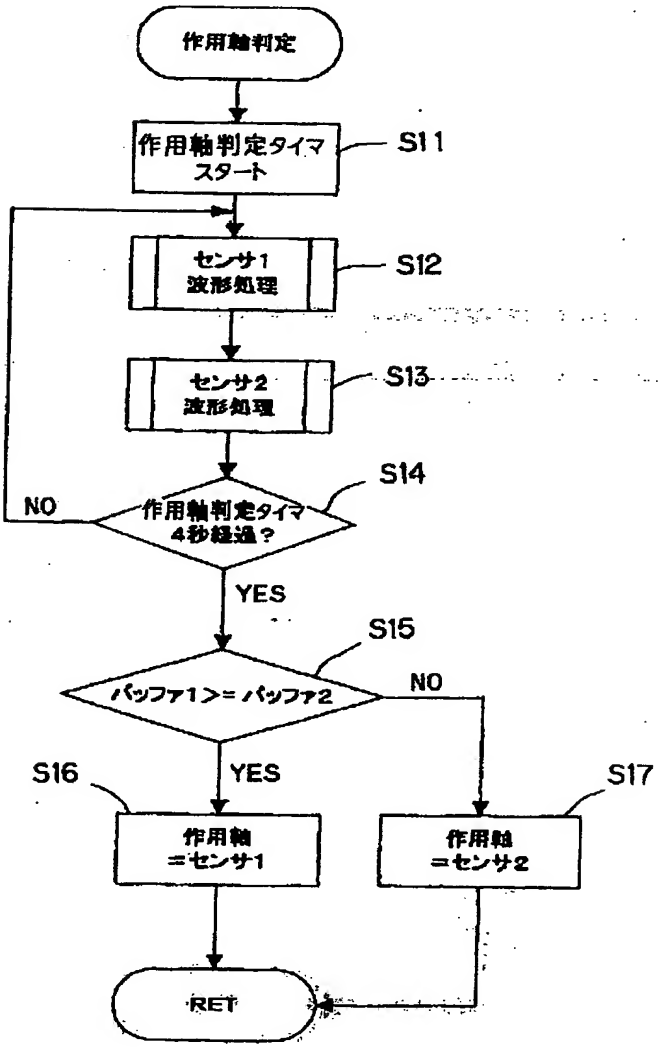
【図５】


19
2
21
23
111
131
LCD
17
112
132
8
133
113
134
15
114

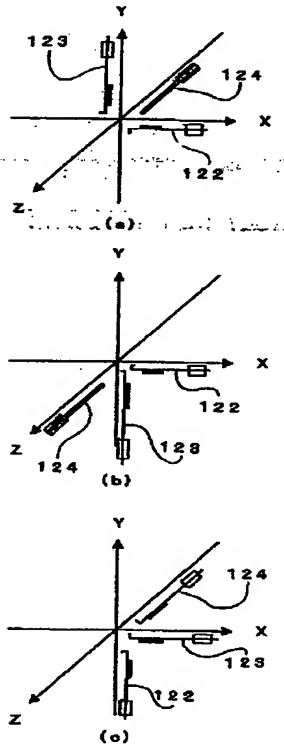
【図１５】


120a
120b
120
120c
(a)
Ts(1)
閾値
Pp(1)
(b)

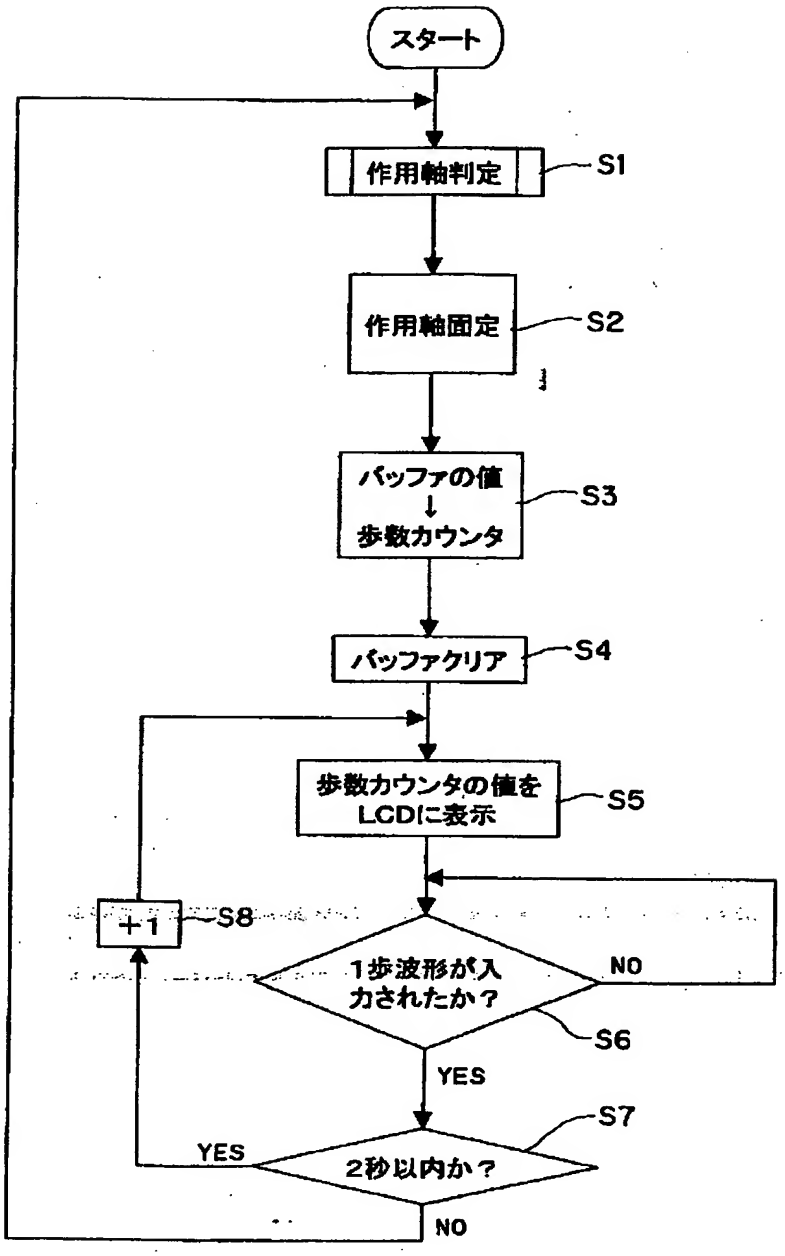
【図７】


作用軸判定
作用軸判定タイマ
スタート
S11
センサ1
波形処理
S12
センサ2
波形処理
S13
S14
NO
作用軸判定タイマ
4秒経過？
YES
S15
バッファ1>=バッファ2
NO
S16
YES
S17
作用軸
=センサ1
作用軸
=センサ2
RET

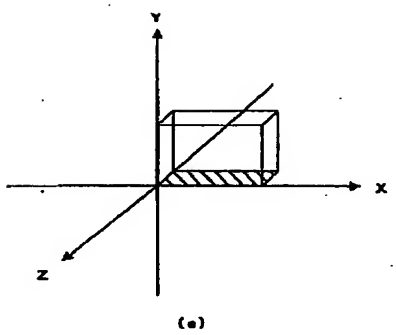
【図２０】


Y
123
124
X
122
Z
(a)
Y
X
122
Z
124
123
(b)
Y
124
X
123
122
Z
(c)

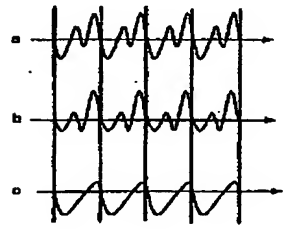
【図６】



【図２１】

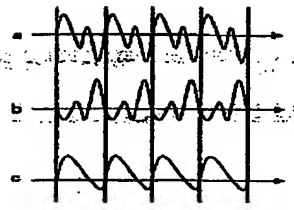


(a)

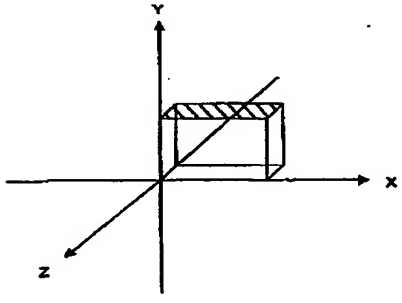


(b)

【図２２】

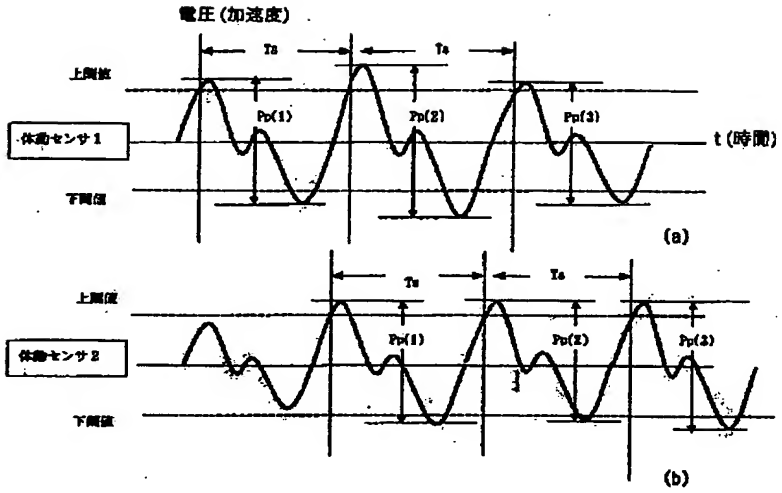


(a)

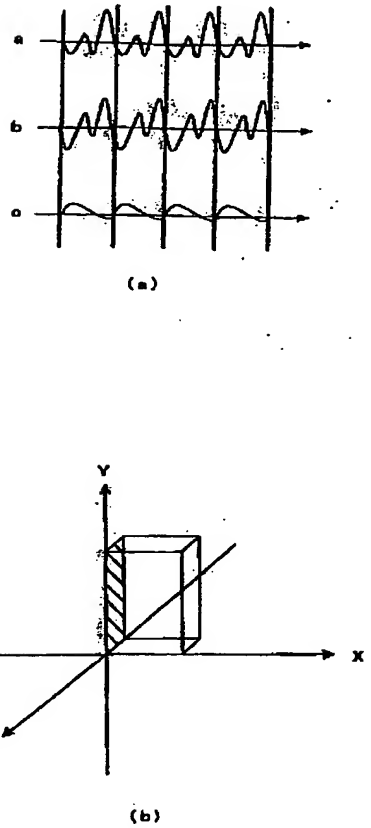


(b)

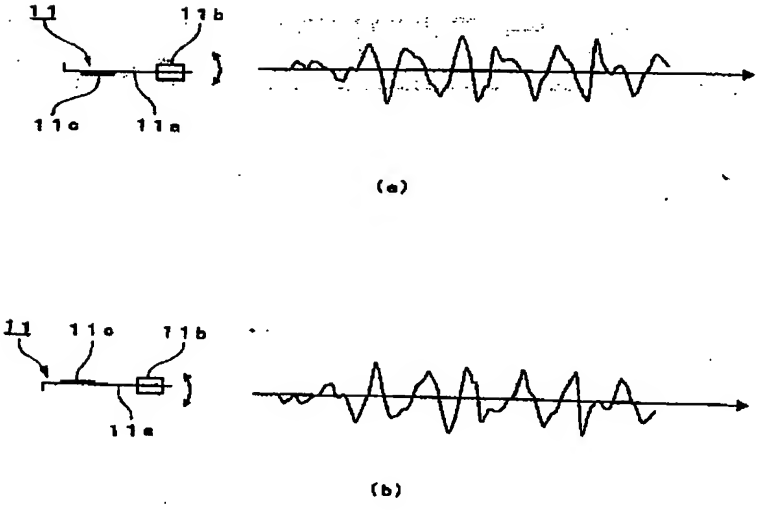
【図８】


電圧(加速度)
Ts
Ts
上閾値
Pp(1)
Pp(2)
Pp(3)
体動センサ1
t(時間)
下閾値
(a)
Ts
Ts
上閾値
Pp(1)
Pp(2)
Pp(3)
体動センサ2
下閾値
(b)

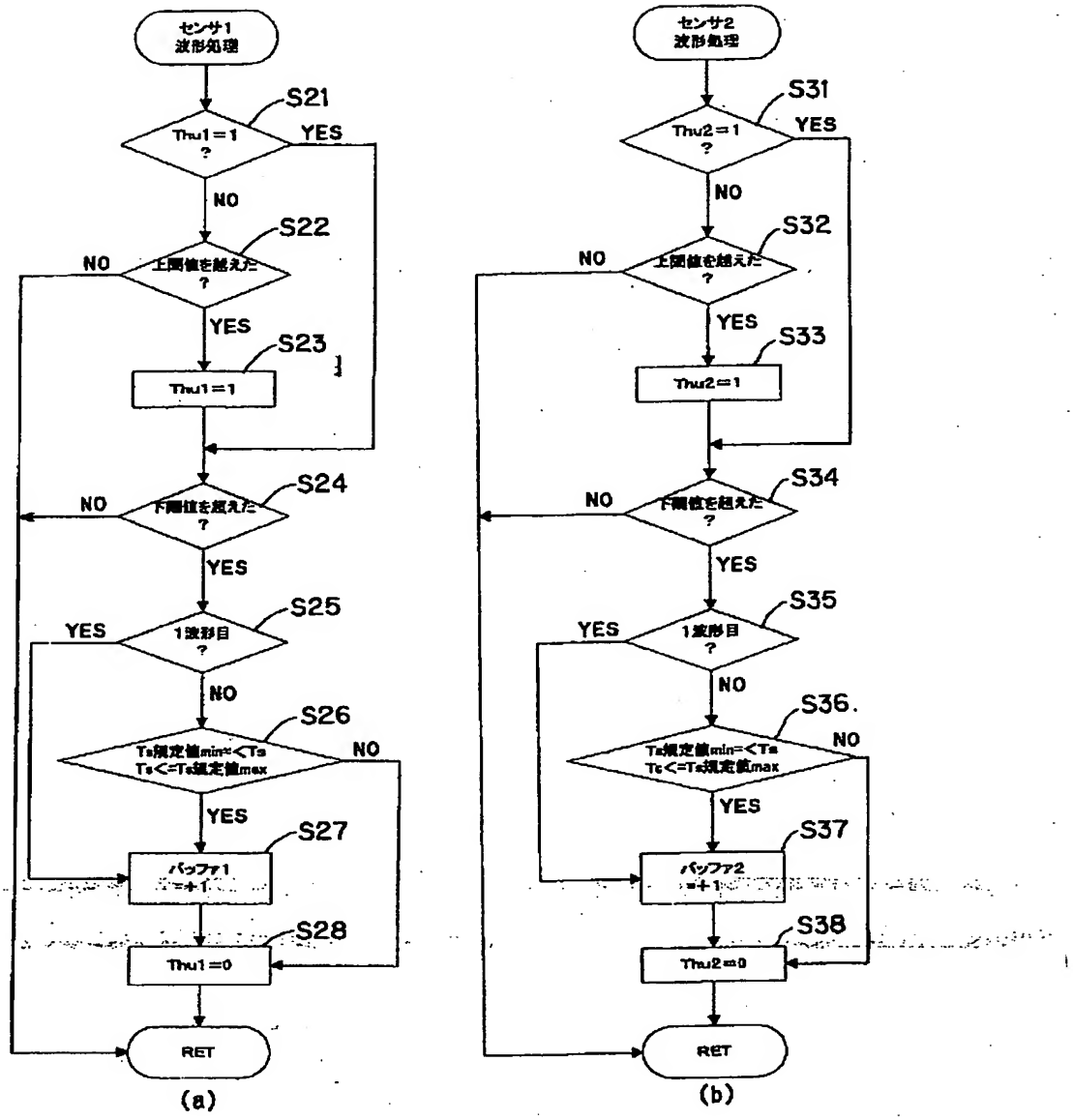
【図２３】


a
b
c
(a)
Y
X
Z
(b)

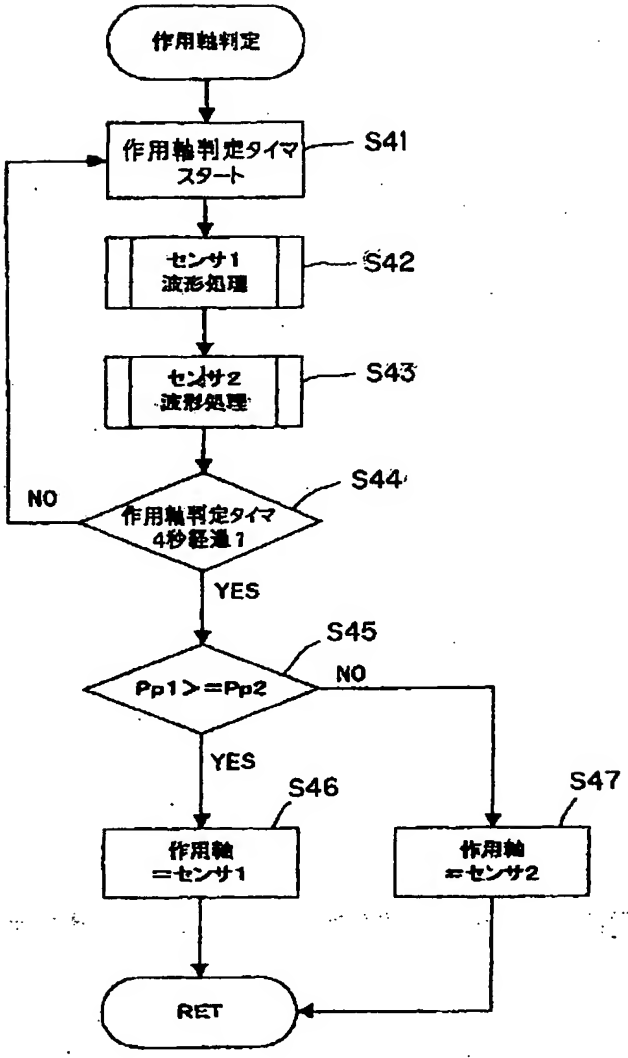
【図１６】


11
11b
11c
11a
(a)
11
11c
11b
11a
(b)

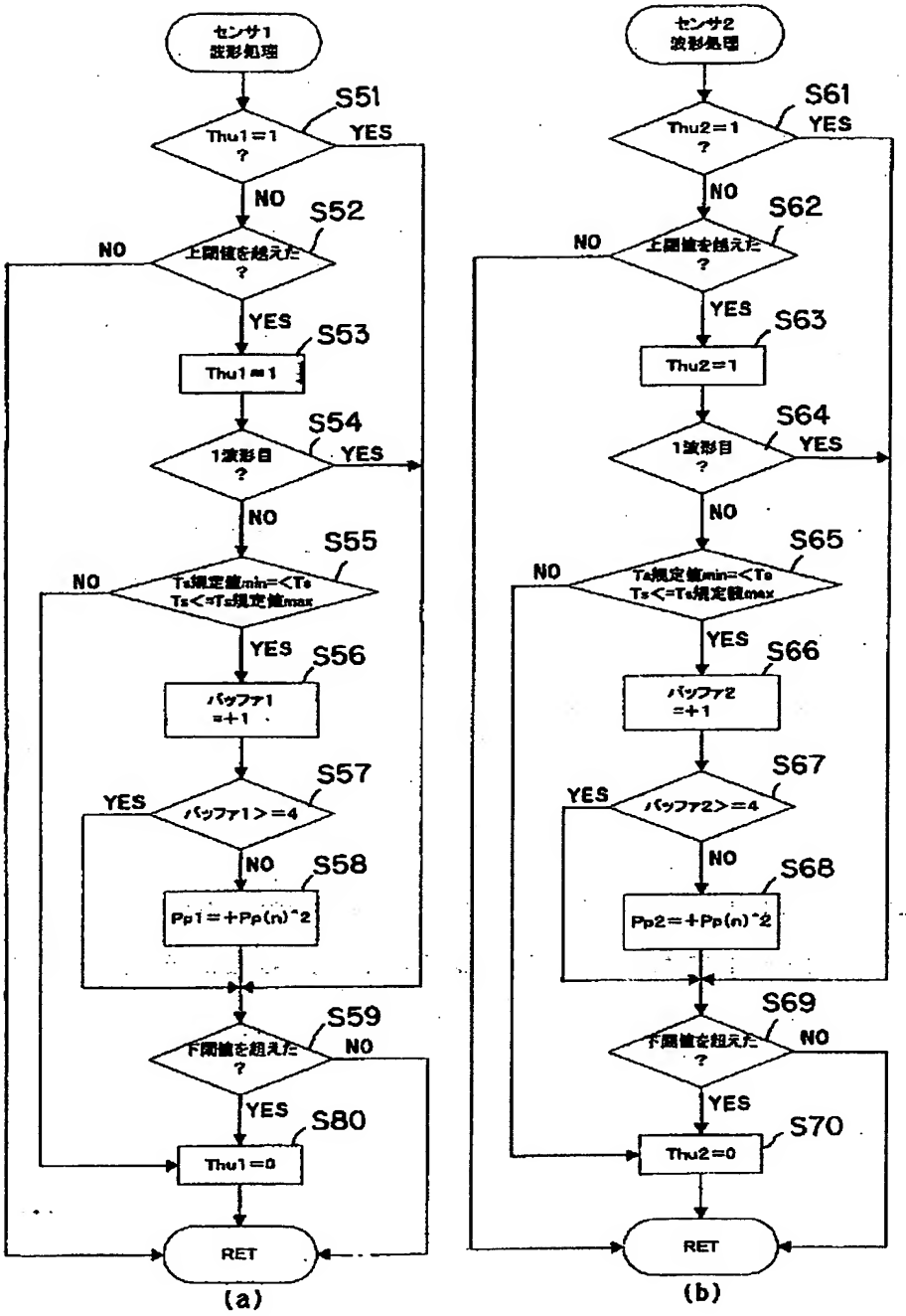
【図９】


センサ1
波形処理
S21
Thu1＝1
？
YES
NO
S22
上閾値を越えた
？
NO
YES
S23
Thu1＝1
S24
下閾値を越えた
？
NO
YES
S25
1波形目
？
YES
NO
S26
Ts規定値min=<Ts
Ts<=Ts規定値max
NO
YES
S27
バッファ1
=+1
S28
Thu1＝0
RET
(a)
センサ2
波形処理
S31
Thu2＝1
？
YES
NO
S32
上閾値を越えた
？
NO
YES
S33
Thu2＝1
S34
下閾値を越えた
？
NO
YES
S35
1波形目
？
YES
NO
S36
Ts規定値min=<Ts
Ts<=Ts規定値max
NO
YES
S37
バッファ2
=+1
S38
Thu2＝0
RET
(b)

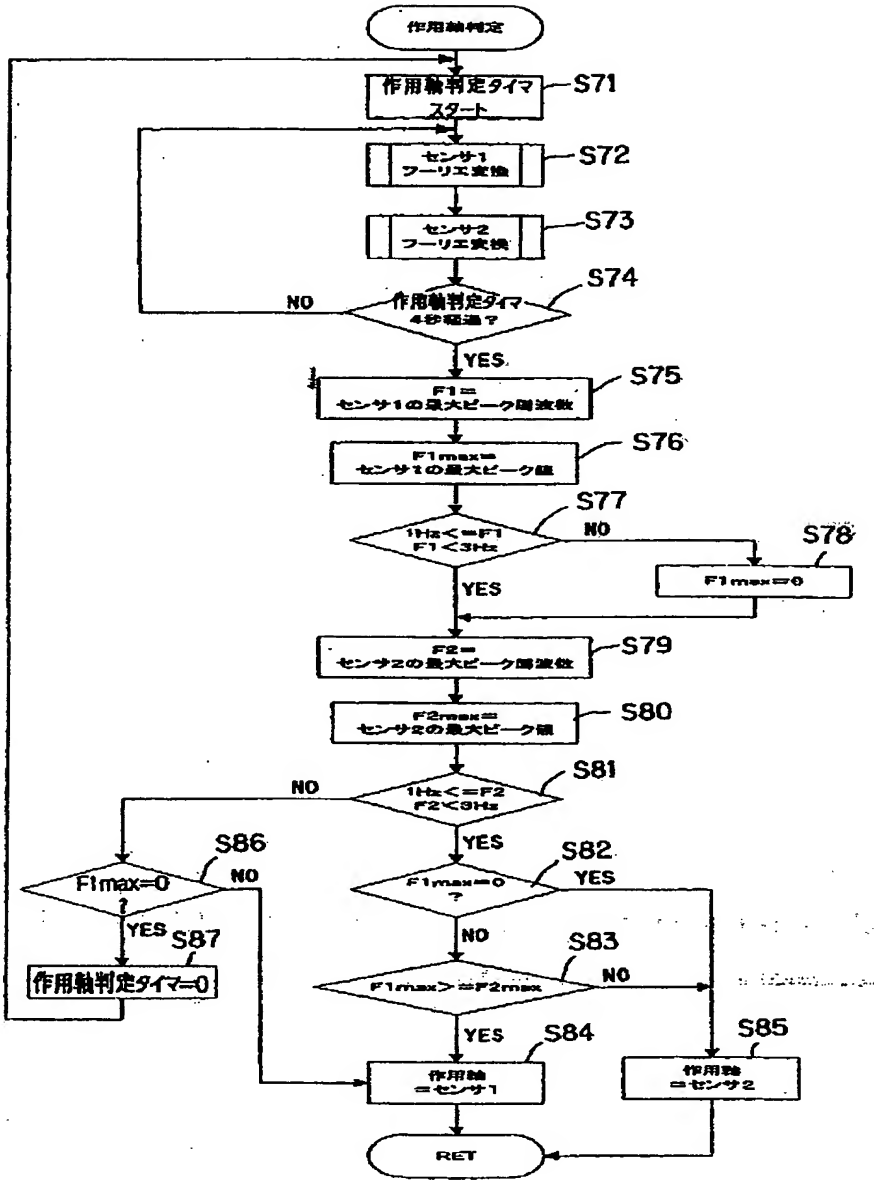
【図１０】


作用軸判定
作用軸判定タイマ
スタート
S41
センサ1
波形処理
S42
センサ2
波形処理
S43
作用軸判定タイマ
4秒経過？
S44
NO
YES
Pp1>=Pp2
S45
NO
YES
S46
S47
作用軸
=センサ1
作用軸
=センサ2
RET

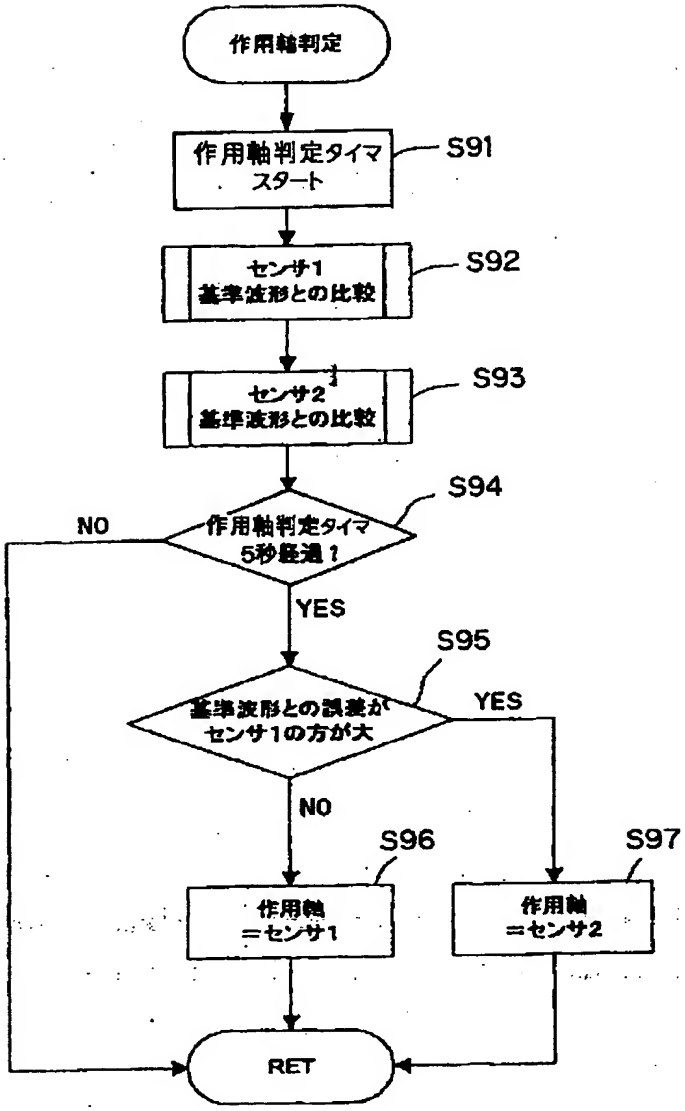
【図１１】


センサ1
波形処理
S51
Thu1＝1
？
YES
NO
S52
上閾値を越えた
？
NO
YES
S53
Thu1＝1
S54
1波形目
？
YES
NO
S55
Ts規定値min=<Ts
Ts<=Ts規定値max
NO
YES
S56
バッファ1
=+1
S57
バッファ1>=4
YES
NO
S58
Pp1=+Pp(n)^2
S59
下閾値を超えた
？
NO
YES
S80
Thu1＝0
RET
(a)
センサ2
波形処理
S61
Thu2＝1
？
YES
NO
S62
上閾値を越えた
？
NO
YES
S63
Thu2＝1
S64
1波形目
？
YES
NO
S65
Ts規定値min=<Ts
Ts<=Ts規定値max
NO
YES
S66
バッファ2
=+1
S67
バッファ2>=4
YES
NO
S68
Pp2=+Pp(n)^2
S69
下閾値を超えた
？
NO
YES
S70
Thu2＝0
RET
(b)

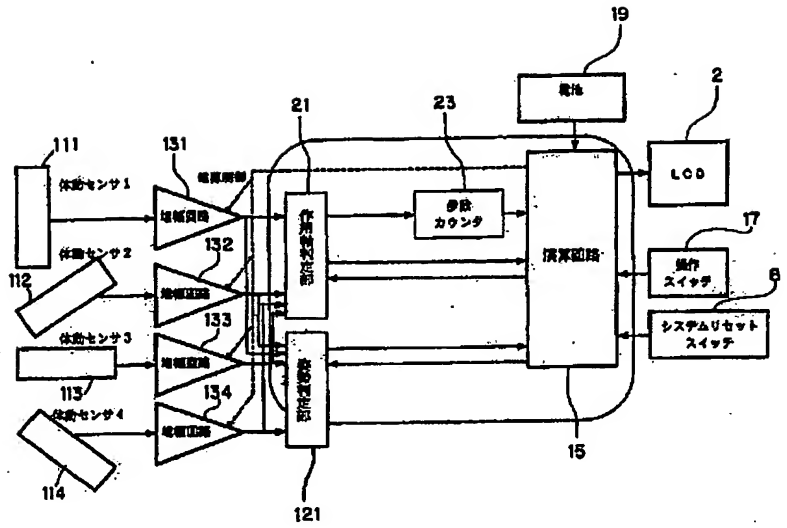
【図１２】


作用軸判定
作用軸判定タイマスタート
S71
センサ1フーリエ変換
S72
センサ2フーリエ変換
S73
作用軸判定タイマ4秒経過？
S74
NO
YES
F1＝センサ1の最大ピーク周波数
S75
F1max＝センサ1の最大ピーク値
S76
1Hz<＝F1 F1＜3Hz
S77
NO
F1max＝0
S78
YES
F2＝センサ2の最大ピーク周波数
S79
F2max＝センサ2の最大ピーク値
S80
1Hz<＝F2 F2＜3Hz
S81
NO
YES
F1max=0？
S86
NO
YES
S87
作用軸判定タイマ=0
F1max=0？
S82
YES
NO
F1max>＝F2max
S83
NO
YES
S84
作用軸＝センサ1
S85
作用軸＝センサ2
RET

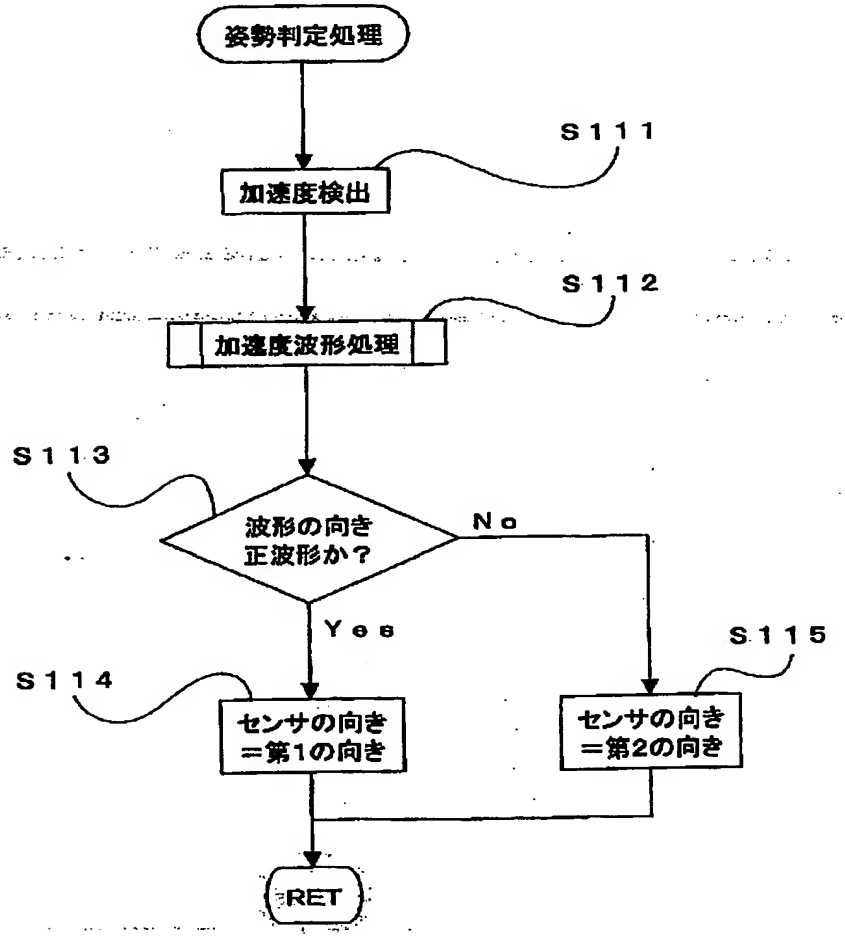
【図１４】


作用軸判定
作用軸判定タイマ
スタート
S91
センサ1
基準波形との比較
S92
センサ2
基準波形との比較
S93
作用軸判定タイマ
5秒経過？
S94
NO
YES
基準波形との誤差が
センサ1の方が大
S95
YES
NO
作用軸
＝センサ1
S96
作用軸
＝センサ2
S97
RET

【図１７】


19
2
21
23
111
131
LCD
体動センサ1
体動センサ2
体動センサ3
体動センサ4
112
113
114
132
133
134
121
15
17
6
LCD
システムリセットスイッチ

【図１９】


姿勢判定処理
S111
加速度検出
S112
加速度波形処理
S113
波形の向き
正波形か？
No
Yes
S114
センサの向き
＝第1の向き
S115
センサの向き
＝第2の向き
RET

フロントページの続き

(72)発明者　宮田　喜一郎
京都府京都市下京区塩小路通堀川東入南不動堂町801番地　株式会社オムロンライフサイエンス研究所内

(72)発明者　木下　弘美
京都府京都市下京区塩小路通堀川東入南不動堂町801番地　株式会社オムロンライフサイエンス研究所内

Fターム(参考)　2F024 AA16 AD03 BA06 BA07 BA10
BA13
4C038 VA12 VA13 VB31

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-191580
(43)Date of publication of application : 09.07.2002

(51)Int.Cl. A61B 5/11
G01C 22/00
G06M 7/00

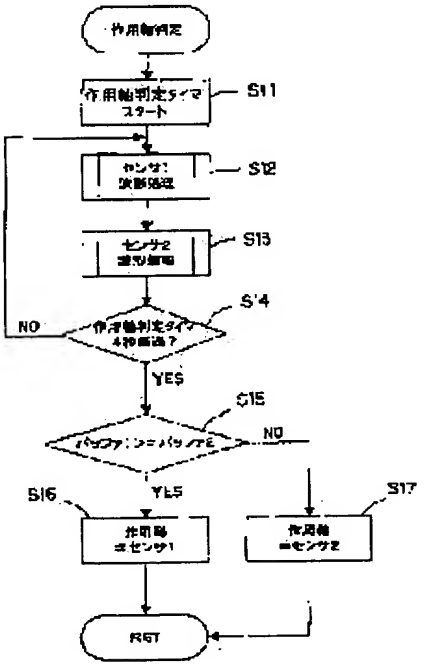
(21)Application number : 2001-102035
(22)Date of filing : 30.03.2001

(71)Applicant : OMRON CORP
(72)Inventor : KUBO MASAO
MIYATA KIICHIRO
KINOSHITA HIROMI

(30)Priority
Priority number : 2000315654 Priority date : 16.10.2000 Priority country : JP

(54) UNIT FOR DETECTING BODY MOTION

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a compact and low-cost body motion detecting unit which is freely fittable and portable and performs detection with high accuracy regardless of a unit posture.
SOLUTION: The body motion detecting unit is provided with two body motion sensors with different body motion detecting directions. In the unit, a waveform is processed in the body motion sensors 1 and 2 (steps 12 and 13) when the body motion is detected, the body sensor 1 is selected as a working axis (step 16) when the number of acceleration waveforms obtained from the output signal of the body motion sensor 1 stored in a buffer 1 becomes equal to or larger than the number of the acceleration waveforms obtained from the output signal of the body motion sensor 1 stored in a buffer 2 after a prescribed time elapses (step 15), the body motion sensor 2 is selected as the working axis (step 17) when a situation is an opposite one, and then, the body motion is detected based on the output signal of the body sensor which is selected as the working axis.



LEGAL STATUS

[Date of request for examination] 23.01.2002
[Date of sending the examiner's decision of rejection] 04.11.2003
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]	
[Patent number]	3543778
[Date of registration]	16.04.2004
[Number of appeal against examiner's decision of rejection]	2003-23532
[Date of requesting appeal against examiner's decision of rejection]	04.12.2003
[Date of extinction of right]	

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2.**** shows the word which can not be translated.
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CLAIMS

[Claim(s)]
[Claim 1] The body motion detection equipment characterized by to have a sensor selection means choose whether it considers as the object of body motion detection of the output signal from which body motion sensor by data processing to the output signal from two or more of said body motion sensors among two or more body motion sensors which are equipment with which a user carries or equips freely and detects a body motion, are arranged so that the directions of a body motion which detect, respectively may differ, and output the signal according to a body motion, and two or more of said body motion sensors.
[Claim 2] Said sensor selection means is body motion detection equipment according to claim 1 characterized by including a signal wave form analysis means to analyze the output signal wave from said body motion sensor.
[Claim 3] Said signal wave form analysis means is body motion detection equipment according to claim 2 characterized by the thing of the frequency analysis of calculation of a number of a signal wave form of counting which fulfill the predetermined conditions acquired in fixed time amount, and the magnitude of a signal wave form, and a signal wave form, and the pattern analysis of a signal wave form for which either is performed at least.
[Claim 4] Said body motion sensor is body motion detection equipment according to claim 1 to 3 characterized by outputting the signal which changes according to the acceleration produced by the body motion.
[Claim 5] The body motion detected by said body motion sensor is body motion detection equipment according to claim 1 to 4 characterized by the thing of a walk and transit included for either at least.
[Claim 6] Two or more body motion sensors which are equipment with which a user carries or equips freely and detects a body motion, are arranged so that the directions of a body motion detected, respectively may differ, and output the signal according to a body motion, A posture judging means to judge the posture of said equipment based on the output signal of two or more of said body motion sensors, Body motion detection equipment characterized by having a body motion detection means to detect a user's body motion by performing data processing according to the posture of said equipment judged by said posture judging means to the output signal of two or more of said body motion sensors.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the body motion detection equipment which measures by choosing the sensor suitable for measurement from two or more sensors, when two

or more sensors which output the signal according to a body motion are formed.
[0002]
[Description of the Prior Art] Conventionally, as body motion detection equipment which chooses from two or more sensors the output signal (or sensor) made into the object of this measurement, there are some which choose one of the output signals of two or more sensors based on the output signal of the mechanism-type include-angle detection sensor like a photo sensor about the output signal of two or more sensors, for example like the pedometer indicated by JP,9-223214,A.
[0003] Moreover, when the wearing direction of equipment is known beforehand, the body motion detection equipment which chooses from two or more sensors the sensor made into the object of this measurement is indicated by JP,11-42220,A.
[0004] moreover, the accelerometer which measures a body motion, using the acceleration sensor of biaxial or three shafts as body motion detection equipment used fixing to the direction and location which were defined beforehand, and identifies walk gestalten, such as the Taira standpoint line, stairway going up, and stairway going down, -- the 11th -- it is indicated by time living body and physiology engineering symposium collected-works BPES'96p.p493-496. The acceleration wave acquired by this report when fixed wearing is carried out and you walk along the acceleration sensor of three shafts on a candidate's lumbar part is analyzed, the walk gestalt is identified, and an accelerometer needs to carry out fixed wearing so that it may not incline to the lumbar part.
[0005]
[Problem(s) to be Solved by the Invention] However, when the detecting element of mechanism types, such as an include-angle detection sensor, was prepared and an output signal was chosen, while the include-angle detection sensor needed to be formed and cost became high separately, there was a problem that equipment became large by the installation tooth space of an include-angle detection sensor.
[0006] Moreover, when the wearing direction of equipment is decided, it will have to be used having to fix the direction of equipment and the case where it can equip will be restricted. Furthermore, the stowed position of equipment was also restricted, and when the wearing direction was mistaken, there were problems -- a right measurement result is not obtained.
[0007] A user can detect a body motion in a precision high irrespective of the posture of equipment in the body motion detection equipment which can be equipped with or carried freely, and this invention has him in offering the body motion detection equipment which can be constituted in low cost and a compact, in order to solve the technical problem of this conventional technique.
[0008]
[Means for Solving the Problem] Two or more body motion sensors which this invention is equipment with which a user carries or equips freely and detects a body motion, and it is arranged so that the directions of a body motion detected, respectively may differ, and output the signal according to a body motion in order to attain the above-mentioned purpose, It is body motion detection equipment characterized by having a sensor selection means to choose whether it considers as the object of body motion detection of the output signal from which body motion sensor among said two or more body motion sensors by data processing to the output signal from said two or more body motion sensors.
[0009] If it does in this way, since a user can choose the body motion sensor which always fitted body motion detection irrespective of the posture of equipment in the body motion detection equipment with which it can carry or equip freely and can detect a body motion based on the output signal of the sensor, a body motion is detectable in a high precision. Moreover, since the body motion sensor suitable for body motion detection is chosen by data processing to the output signal of two or more body motion sensors, it is not necessary to establish means, such as an angle sensor, separately, and the body motion detection equipment which can be constituted in low cost and a compact can be offered.
[0010] Moreover, it is suitable for said sensor selection means to include a signal wave form analysis means to analyze the output signal wave from said body motion sensor.
[0011] moreover, the frequency analysis of calculation of a number of a signal wave form of

counting with which said signal wave form analysis means fills the predetermined conditions acquired in fixed time amount, and the magnitude of a signal wave form, and a signal wave form and the pattern analysis of a signal wave form -- it may be made to perform either at least.
[0012] Moreover, it is suitable for said body motion sensor to output the signal which changes according to the acceleration produced by the body motion.
[0013] Moreover, the thing of a walk and transit which the body motion detected by said body motion sensor includes for either at least is suitable.
[0014] Moreover, two or more body motion sensors which this invention is equipment with which a user carries or equips freely and detects a body motion, are arranged so that the directions of a body motion detected, respectively may differ, and output the signal according to a body motion, A posture judging means to judge the posture of said equipment based on the output signal of two or more of said body motion sensors, It is characterized by having a body motion detection means to detect a user's body motion by performing data processing according to the posture of said equipment judged by said posture judging means to the output signal of two or more of said body motion sensors.
[0015] If it does in this way, since a user can carry or equip freely and can detect body motions, such as discernment of a walk gestalt, a user's degree of freedom spreads.
[0016]
[Embodiment of the Invention] Hereafter, this invention is explained based on the operation gestalt of illustration.
[0017] (1st operation gestalt) Drawing 1 is the appearance perspective view showing the pedometer as body motion detection equipment concerning the operation gestalt of this invention, and drawing 2 is this top view.
[0018] A pedometer 10 is a flat solid configuration and is making the configuration where the side face removed the end section of the long side of an ellipse form. Moreover, string supporter 10a which has the hole which inserts a string etc. in the other end of the long side of an ellipse form projects, and is formed. The display screen 2 which consists of LCD etc., a configuration switch 3, memory / ** switch 4, the display change-over switch 5, and the reset switch 6 are formed in the front face of a case 1. The cell covering 7 and the system-reset switch 8 are formed in the rear face of a case 1.
[0019] Assignment of a stowed position is made by an operation manual etc. as there is a posture generally recommended in a pedometer, for example, the lumbar part, such as a belt, pants, a skirt board, and trousers, is certainly equipped with a clip. Even when a pedometer is held with the posture always recommended like [when putting in into a pocket or putting in into ********** or a bag from the neck] on the other hand, in this pedometer 10, highly precise counting is possible.
[0020] Drawing 3 shows typically arrangement of the body motion sensor inside [case 1] a pedometer (however, other configurations within cases, such as the circuit board, are omitted.).
[0021] The body motion sensor used with this operation gestalt is an acceleration sensor which outputs the signal which changes according to the acceleration produced by the body motion. Including tabular base material 11a, weight 11b prepared in the base material edge, and detection section 11c which consists of a piezoelectric device formed on the base material side, the body motion sensor 11 (other body motion sensor 12 grades are the same) changes into the voltage signal of piezoelectric-device 11c deformation (distortion) of base material 11a produced with the acceleration which originates in a body motion and acts on weight, and takes it out.
[0022] In drawing 3 (a), the body motion sensors 11 and 12 are arranged in the XY direction which intersects perpendicularly mutually. Three or more body motion sensors may be arranged like drawing 3 (b). In addition to the body motion sensor 111,112 of the XY direction which intersects perpendicularly mutually, in drawing 3 (b), one body motion sensor 113 and the body motion sensor 114 which detects the body motion of the Z direction which intersects perpendicularly further at the flat surface at which three body motion sensors 111,112,113 have been arranged are arranged in about 45-degree direction across which it faces in the XY direction. Since any output of the body motion sensor 111,112 becomes small about a body motion with an include angle of about 45 degrees inserted in the XY direction, in such a case, the body

motion sensor 113 is effective.
[0023] Drawing 4 is the block diagram showing the internal configuration of a pedometer 10.
[0024] The body motion sensors 11 and 12 for body motion detection arranged in the XY direction in which a pedometer 10 mainly intersects perpendicularly mutually, The amplifying circuits 13 and 14 which amplify the output voltage of the body motion sensors 11 and 12, a cell 19, and time of day and the number of steps - continuation -- the number of steps -- with LCD2 which displays - continuation walk time amount and a consumption calorie It consists of an arithmetic circuit 15 which controls the actuation switch 17, the system-reset switch 8, a LCD display control and actuation switch input detection, sequence control, current supply, etc. of configuration-switch 3 grade.
[0025] The signal acquired from the body motion sensors 11 and 12 is inputted into the operation shaft judging section 21. the signal of the operation shaft with which the operation shaft was chosen and chosen in the operation shaft judging section 21 -- using -- the number of steps -- the number of steps is counted with a counter 23.
[0026] Drawing 5 is the block diagram of the pedometer which has four body motion sensors as shown in drawing 3 (b). Since it has the same configuration as the pedometer shown in drawing 4 except for the point that a total of four amplifying circuits are prepared for every body motion sensor, detailed explanation is omitted. With the body motion detection equipment concerning this invention, the number of a body motion sensor is not restricted to an above-mentioned thing.
[0027] (The number processing of pedometers) Below, the number processing of pedometers in which the pedometer was used is explained.
[0028] Drawing 6 is a flow chart which shows the procedure of the main routine of the number processing of pedometers in a pedometer.
[0029] First, processing is started by the input of the output signal from a body motion sensor.
[0030] Operation shaft judging processing is performed based on the output from the amplifying circuit connected to two or more body motion sensors inputted into the operation shaft judging section (step 1). It is fixed to a specific operation shaft by judgment processing of an operation shaft (step 2). next, the output data from the body motion sensor corresponding to the fixed operation shaft -- the number of steps from a buffer -- counting of delivery and the number of steps is carried out to a counter (step 3). The data of a buffer are eliminated in connection with this (step 4). next, the number of steps -- the number of steps by which counting was carried out with the counter is displayed on LCD (step 5). At this time, the number of steps of the walk detected by the body motion sensor corresponding to an above-mentioned operation shaft is displayed on LCD. Next, it judges whether the wave of one step was inputted (step 6). If step 6 is repeated and the wave of one step is inputted until the wave of one step is inputted, it will judge whether it was inputted within 2 seconds (step 7). if it is less than 2 seconds -- the number of steps -- the count of a counter is carried out +one (step 8), and it returns to step 5. If it is not less than 2 seconds, it will return to step 1.
[0031] (Operation shaft judging processing) First, an acceleration sensor constitutes a body motion sensor and the case where operation shaft judging processing is performed using the number of acceleration waves obtained in fixed time amount as analysis of an acceleration wave obtained at the time of a walk is explained.
[0032] Drawing 7 is a flow chart which shows the procedure of operation shaft judging processing.
[0033] First, an operation shaft judging timer is started (step 11).
[0034] Next, wave processing of the body motion sensor 1 is performed (step 12), and wave processing of the body motion sensor 2 is performed (step 13).
[0035] Here, the example of an acceleration wave acquired by the body motion sensor 1 and the body motion sensor 2 is shown in drawing 8 . In drawing 8 , an axis of abscissa is time amount (sense to which time amount progresses [the method of the right]), and an axis of ordinate is acceleration (for example, expressed and carried out by the electrical potential difference.).
[0036] Next, it judges whether the time check of an operation shaft judging timer has passed 4 seconds (step 14). If 4 seconds have not passed, it returns to step 12. The number of acceleration waves obtained from the output signal of the body motion sensor 1 stored in the buffer 1 when 4 seconds had passed, For example, the number of acceleration waves obtained at the time of a

walk (in the flow chart, this is written as "the buffer 1".) The number of acceleration waves obtained from the output signal of the body motion sensor 2 stored in the buffer 2 (in the flow chart, this is written as "the buffer 2".) It judges whether it has a relation that it is large or equal (step 15). When the relation that it is larger than the number of acceleration waves obtained from the output signal of the body motion sensor 2 by which the number of acceleration waves obtained from the output signal of the body motion sensor 1 stored in the buffer 1 is stored in the buffer 2, or equal is realized, the body motion sensor 1 is chosen as an operation shaft (step 16), and operation shaft judging processing is ended. When the relation that it is larger than the number of acceleration waves obtained from the output signal of the body motion sensor 2 by which the number of acceleration waves obtained from the output signal of the body motion sensor 1 stored in the buffer 1 is stored in the buffer 2, or equal is not realized, the body motion sensor 2 is chosen as an operation shaft (step 17), and operation shaft judging processing is ended. That is, the direction with many acceleration waves is chosen as an operation shaft.

[0037] (Wave processing) Drawing 9 (a) is a flow chart which shows the procedure of wave processing of the body motion sensor 1.

[0038] It judges whether the acceleration wave acquired from the output signal of the body motion sensor 1 is already over the upper threshold with a flag (Thu1) (step 21). If it is Thu 1= 0, if a judgment is repeated (step 22) and an upper threshold is exceeded until it exceeds an upper threshold, a flag (Thu1) will be set to 1 (step 23), and it will progress to the judgment of a bottom threshold. On the other hand, if it is Thu 1= 1, it will progress to the judgment of a bottom threshold. Here, the judgment of whether the acceleration wave acquired from the output signal of the body motion sensor 1 exceeded the bottom threshold is repeated until an acceleration wave exceeds a bottom threshold (step 24), and if a bottom threshold is exceeded, an acceleration wave will judge whether it is 1 wave eye (step 25). For example, if it is the acceleration wave acquired at the time of a walk, 1 will be added to the value with which 1 wave eye was unconditionally stored in the buffer (step 27), and if it is after 2 wave eye It judges whether spacing with 1 wave front is in convention spacing (Ts default value min<= Ts and Ts<= Ts default value max) (step 26), and if it is in convention spacing, 1 will be added to the value stored in the buffer (step 27). Then, a flag is set to 0 (Thu1) (step 28), and it is repeated until an axial judgment timer passes for 4 seconds. Although drawing 8 (b) is a flow chart which shows the procedure of wave processing of the body motion sensor 2, since the detail of processing is the same as that of drawing 8 (a), explanation is omitted. The judgment performed at step 26 is the meaning which eliminates signals other than the signal by walk from the output signal of a body motion sensor.

[0039] Thus, since the output of a body motion sensor suitable in software is taken out and counting, such as the number of steps, is performed, without establishing separately the posture detection means of equipments, such as an angle sensor of a mechanism type, the tooth space and cost for a posture detection means become unnecessary. Therefore, low cost and a compact pedometer can be constituted.

[0040] in addition, the equipment which detects and uses a body motion although this operation gestalt explains only the pedometer as body motion detection equipment -- it is -- ****ing -- the number of steps -- naturally what is changed into the index of an except is contained.

[0041] (2nd operation gestalt) The 2nd operation gestalt of this invention is explained hereafter. Since it is the same as that of the 1st operation gestalt about the internal configuration of a pedometer, and the number processing of pedometers, only a different part is explained.

[0042] With this operation gestalt, operation shaft judging processing is performed using the power value of an acceleration wave as analysis of an acceleration wave obtained at the time of a walk.

[0043] (Operation shaft judging) Drawing 10 is a flow chart which shows the procedure of operation shaft judging processing.

[0044] Since the processing to step 41 - step 44 is the same as that of the case where the number of acceleration waves shown in drawing 7 is used, explanation is omitted.

[0045] The power value of an acceleration wave acquired from the body motion sensor 1 and the body motion sensor 2 when the operation shaft judging timer passed for 4 seconds (the square of a peak-to-peak value (maximum among the algebraic difference between the extremal value of

the acceleration wave within the predetermined section) defines.), For example, the aggregate value (Pp(1)2+Pp(2)2+Pp(3) 2) (in drawing 9 , it is written as Pp1 and Pp2) of the power value (2) of 3 waves of the beginning of the waves acquired in 4 seconds is compared (step 45). The one where the aggregate value of a power value is larger is chosen as an operation shaft as a result of a comparison (steps 46 and 47). Moreover, the magnitude of the absolute value of p-p may compare.

[0046] (Wave processing) Drawing 11 (a) is a flow chart which shows the procedure of wave processing of the body motion sensor 1.

[0047] First, it is the flow chart which shows the procedure of wave processing of the body motion sensor 1.

[0048] It judges whether the acceleration wave acquired from the output signal of the body motion sensor 1 is already over the upper threshold with a flag (Thu1) (step 51). If it is Thu 1= 0, if a judgment is repeated (step 52) and an upper threshold is exceeded until it exceeds an upper threshold, a flag (Thu1) will be set to 1 (step 53), and it will judge whether it is 1 wave eye (step 54). Here, if it is 1 wave eye, it will progress to the judgment of the bottom threshold of step 59, and if it is after 2 wave eye, it will judge whether spacing (Ts) with 1 wave front is in convention spacing (Ts default value min<= Ts and Ts<= Ts default value max) (step 55). If Ts is convention within the limits, 1 is added to the value stored in the buffer (step 56), and the power value (2) of an acceleration wave will be computed and it will add to the power value of a prewave form (step 57). For example, only the first 3 waves acquired in 4 seconds are added to Pp1 (step 57). On the other hand, when it is Thu 1= 1 in step 53, or as well as the case where a power value is added when it is 1 wave eye in step 54, it progresses to the judgment of a bottom threshold. Here, the judgment of whether the acceleration wave acquired from the output signal of the body motion sensor 1 exceeded the bottom threshold is repeated until an acceleration wave exceeds a bottom threshold (step 59), and it is repeated until it will set a flag to 0 (Thu1) (step 60) and an axial judgment timer will pass for 4 seconds, if a bottom threshold is exceeded. Although drawing 11 (b) is a flow chart which shows the procedure of wave processing of the body motion sensor 2, since the detail of processing is the same as that of drawing 11 (a), explanation is omitted.

[0049] Although addition of a power value was made into the first aggregate value of 3 waves acquired in 4 seconds in above-mentioned processing, 2 waves or three waves or more are sufficient. Moreover, it is not necessary to use it from 1 wave eye.

[0050] (3rd operation gestalt) The 3rd operation gestalt of this invention is explained hereafter. Since it is the same as that of the 1st operation gestalt about the internal configuration of a pedometer, and the number processing of pedometers, only a different part is explained.

[0051] With this operation gestalt, operation shaft judging processing is performed using the frequency analysis of an acceleration wave as analysis of an acceleration wave obtained at the time of a walk.

[0052] (Operation shaft judging processing) Drawing 12 is a flow chart which shows the procedure of operation shaft judging processing.

[0053] First, an operation shaft judging timer is started (step 71).

[0054] Next, the Fourier transform of the acceleration wave acquired by the body motion sensor 1 is carried out (step 72), and the Fourier transform of the acceleration wave acquired by the body motion sensor 2 is carried out (step 73).

[0055] The example of the frequency distribution acquired by drawing 13 (a) and (b) by carrying out the Fourier transform of the acceleration wave acquired by the body motion sensor 1 and the body motion sensor 2, respectively is shown. As shown in drawing 13 (a), there is nothing, for example, a high peak (height F1max) is seen in the location (F1) which dispersion likes extremely as for frequency distribution of the body motion sensor 1 of an acceleration wave and which is 2Hz. As shown in drawing 13 (b), frequency distribution of the body motion sensor 2 of an acceleration wave varies, a low peak (height F2max) is in the location (F2) of 2.1Hz, and a lower peak exists in other frequencies. As for this example, the condition that the signal which the acceleration change by the body motion which should be detected in body motion sensor 1 direction is detected, and includes an unnecessary vibration from which the body motion which should be detected in a body motion sensor 2-way differs is detected is shown.

[0056] Next, an operation shaft judging timer repeats steps 72 and 73, for example until it judges whether 4 seconds passed (step 74) and passes 4 seconds in it. [0057] When the time check of an operation shaft judging timer passes 4 seconds, the value (all encompassing of an F1max= power value) of a frequency (F1) with the analysis result of an acceleration wave obtained from the body motion sensor 1 and the maximum peak and the maximum peak is detected (steps 75 and 76). Next, F1 judges whether it is the inside of a convention frequency range (step 77), and if it is outside a convention frequency range, the zero clear of the F1max will be carried out (step 78). Here, normal frequency is set to 1Hz - 3Hz, for example. The value (all encompassing of an F2max= power value) of a frequency (F2) with the analysis result of an acceleration wave similarly obtained from the body motion sensor 2 and the maximum peak and the maximum peak is detected (steps 79 and 80), and F2 judges whether it is the inside of a convention frequency range (step 81). If F2 is in a convention frequency range, F1max will judge whether it is 0 (step 82). At this time, if F1max becomes zero, the body motion sensor 2 will be chosen as an operation shaft (step 85). On the other hand, if F1max is not 0, it will judge whether it is F1 max>=F2max (step 83). Here, if it becomes F1 max>=F2max, the body motion sensor 1 will be chosen as an operation shaft (step 84). Moreover, if stepF2 is outside a convention frequency range in 81, F1max will judge whether it is 0 (step 86). Here, if it is not F1max=0, the body motion sensor 1 will be chosen as an operation shaft (step 84). If it is F1max=0, the zero clear of the axial judgment timer will be carried out (step 87), and it returns to step 71, and an operation shaft judging is performed again.

[0058] (4th operation gestalt) The 4th operation gestalt of this invention is explained hereafter. Since it is the same as that of the 1st operation gestalt about the internal configuration of a pedometer, and the number processing of pedometers, only a different part is explained.

[0059] With this operation gestalt, operation shaft judging processing is performed using the pattern analysis of an acceleration wave as analysis of an acceleration wave obtained at the time of a walk.

[0060] (Operation shaft judging processing) Drawing 14 is a flow chart which shows the procedure of operation shaft judging processing.

[0061] First, an operation shaft judging timer is started (step 91). Next, the acceleration wave acquired from the body motion sensor 1 and the body motion sensor 2 is compared with a reference waveform (steps 92 and 93). For example, it asks for the reference waveform from the data collected beforehand, and it compares with the wave detected at the time of measurement. An operation shaft judging timer repeats steps 92 and 93, for example until it passes for 5 seconds (step 94). If 5 seconds of a time check of an operation shaft judging timer pass, an operation shaft will be chosen by the pattern-analysis result of an acceleration wave obtained in 5 seconds. Here, it judges whether the acceleration wave [error / with a reference waveform] from the body motion sensor 1 is larger (step 95). If the acceleration wave [error / with a reference waveform] from the body motion sensor 1 is larger, the body motion sensor 2 will be chosen as an operation shaft (step 97), and if equal or the acceleration wave [error / with a reference waveform] from the body motion sensor 1 is smaller, the body motion sensor 1 will be chosen as an operation shaft (step 96).

[0062] As an above-mentioned pattern analysis of an acceleration wave, you may compare with the reference waveform beforehand called for using the peak value of an acceleration wave, wave-like width of face, peak spacing (period), the crest in 1 wave, the number of troughs, etc., the stability of the appearance of a detection wave using said parameter may be used, and the wave-like pattern analysis using a cluster-analysis method etc. may be used, for example.

[0063] (5th operation gestalt) The pedometer as body motion detection equipment which has a different body motion sensor from the above-mentioned operation gestalt as 5th operation gestalt is explained. Since the configuration of those other than a body motion sensor is the same as that of the 1st thru/or 4th operation gestalt, explanation is omitted.

[0064] Drawing 15 (a) shows the body motion sensor 120 used for the body motion detection equipment concerning this operation gestalt.

[0065] It is the acceleration sensor which outputs the signal with which the body motion sensor 120 also changes according to the acceleration produced by the body motion. The body motion

sensor 120 contains reed switch 120c which rocks the supporting point as a core, is prepared in the predetermined location near the rocking range of pendulum 120a by which it was equipped with magnet 120b at the tip, and pendulum 120a, becomes ON by contiguity of magnet 120b, and becomes off by alienation. The rocking range of a pendulum is regulated by the non-illustrated stopper. Moreover, pendulum 120a is constituted so that the pendulum rocked with energization means, such as a vine firewood spring, may return to a predetermined location. Pendulum 120a rocked with the acceleration which originates in a body motion and acts on a pendulum, and rocking of this pendulum 120a is changed and taken out to change of the electrical potential difference or current produced by 120c closing motion of the reed switch by contiguity of magnet 120b.

[0066] The output signal of the body motion sensor 120 serves as pulse shape, as shown in drawing 15 (b). Although the spacing Ts between pulses (1) is similarly defined as the acceleration wave shown in drawing 8 , pulse width is defined as Pp (1) here. By the body motion sensor 120, since, as for the magnitude of the acceleration by the body motion, the rocking include angle of pendulum 120a becomes large and the time amount to which magnet 120b is close to reed switch 120c becomes long, pulse width becomes large. For this reason, pulse width is defined as Pp.

[0067] The operation shaft judging processing in the 1st operation gestalt is applicable also to the body motion sensor concerning this operation gestalt by making the number of acceleration waves into the number of pulse shape.

[0068] Moreover, the operation shaft judging in the 2nd operation gestalt is applicable also to the body motion sensor concerning this operation gestalt by defining Pp as mentioned above.

[0069] Moreover, since the operation shaft judging processing in the 3rd and 4th operation gestalten can perform same analysis processing also with pulse shape, it is applicable also to the body motion sensor concerning this operation gestalt.

[0070] Although the above-mentioned body motion sensor 120 has detected rocking of a pendulum with the combination of a magnet and a lead sensor, the tip of a pendulum may form a photo interrupter, and may not be intermittent in an optical path with rocking of a pendulum, and it is not restricted to these configurations.

[0071] (6th operation gestalt) The body motion detection equipment concerning the 6th operation gestalt of this invention is explained hereafter. With the output of a body motion sensor, the body motion detection equipment concerning this operation gestalt judges the posture of the body motion detection equipment freely carried or carried by the user, and, in addition to counting of the number of steps, or this, identifies walk gestalten, such as the Taira standpoint line, stairway going up, and stairway going down, based on the posture.

[0072] First, the principle which judges the posture of body motion detection equipment is explained.

[0073] In drawing 16 , it explains using the body motion sensor 11 concerning the pedometer concerning the 1st operation gestalt, and the body motion sensor which has the same configuration. About a sign, the same sign as the body motion sensor 11 is used. The body motion sensor 11 is an acceleration sensor which outputs the signal which changes according to the acceleration which is equipped with detection section 11c which consists of a piezoelectric device formed on one field of tabular base material 11a, and weight 11b formed in the edge, and is produced by the body motion.

[0074] The condition that detection section 11c is located in the top face of base material 11a in the condition that detection section 11c is located in the inferior surface of tongue of base material 11a about direction of the body motion sensor 11 as shown in drawing 16 (a) as shown in the 1st sense and drawing 16 (b) is defined as the 2nd sense. the case where movement of the direction of an arrow head produces the wave displayed on the right-hand side of the body motion sensor 11 of drawing 16 (a) and (b) here -- (-- the sense of movement is the same irrespective of the sense of a body motion sensor.) -- the acceleration wave outputted from the body motion sensor 11, respectively is shown. Since the methods of the deformation produced in a piezoelectric device differ according to whether detection section 11c is formed on which [of base material 11a] field even when the same movement arises, the waves outputted also differ.

Therefore, if the acceleration wave outputted from the body motion sensor 11 arranged at the 1st sense shown in drawing 16 R> 6 (a) is made into a forward wave, from the body motion sensor 11 arranged at the 2nd sense shown in drawing 16 (b), the reversed acceleration wave (cross-sea form) will be outputted.

[0075] Therefore, if the pattern of an acceleration wave by various movements in the case of taking the posture in which body motion detection equipment (or body motion sensor) serves as criteria to a user or space is memorized beforehand, it will become possible to judge the posture of body motion detection equipment by comparing with the pattern of an acceleration wave at the time of a criteria posture the pattern of an acceleration wave outputted from a body motion sensor. That is, the posture of body motion detection equipment can be judged in software by data processing to the output signal from a body motion sensor, without having mechanism-equipment for a special posture judging.

[0076] The block diagram of the body motion detection equipment 100 applied to this operation gestalt at drawing 17 is shown. About the same configuration as the 1st operation gestalt, explanation is omitted using the same sign.

[0077] With this operation gestalt, the signal acquired from the body motion sensors 111-114 is inputted into the posture judging section (posture judging means) 121. In the posture judging section 121, the posture of body motion detection equipment 100 is judged, and data processing, such as discernment of a walk gestalt, is performed in an arithmetic circuit (body motion detection means) 15 based on the judged posture. this operation gestalt -- the 1st operation gestalt -- the same -- the operation shaft judging section 21 and the number of steps -- these configurations are also omissible although it has the counter 23.

[0078] (Body motion detection processing) Drawing 18 is a flow chart which shows the procedure of the main routine of the body motion detection processing in body motion detection equipment 100.

[0079] First, processing is started by the input of the output signal from the body motion sensors 111-114.

[0080] Posture judging processing later mentioned based on the output from the amplifying circuit connected to two or more body motion sensors 111-114 inputted into the posture judging section 121 is performed (step 101).

[0081] Next, body motion detection processing is performed based on the posture of the body motion detection equipment 100 judged by posture judging processing (step 102). here -- as body motion detection processing -- the 11th -- time living body and physiology engineering symposium collected-works BPES'96p.p493-496 -- discernment processing of the walk gestalt in the 1st operation gestalt can be performed. Since the posture of body motion detection equipment 100 to a user can be specified by posture judging processing even if the user has carried or equipped freely, the body motion of the predetermined directions, such as 3 shaft orientations fixed to a user or space, can be detected, and a walk gestalt can be identified. this -- the 1-counting of the number of steps explained in the 5th operation gestalt -- counting of the number of steps in each walk gestalt can be carried out combining processing.

[0082] (Posture judging processing) Next, the subroutine of above-mentioned posture judging processing is explained according to the flow chart shown in drawing 19 .

[0083] First, each body motion sensor detects acceleration (step 111).

[0084] Next, acceleration wave processing to the detected acceleration wave is performed (step 112).

[0085] Next, the obtained sense of an acceleration wave judges whether it is a forward wave (step 113). Although the case where the number of body motion sensors is one is explained here, it is also the same as when it has two or more body motion sensors. Moreover, a forward wave points out the wave which starts in the forward direction as shown in drawing 1616 (a).

[0086] If the sense of an acceleration wave is a forward wave, it will be judged that the sense of a body motion sensor is the 1st sense as shown in drawing 16 (a) (step 114), and the sense of a body motion sensor is the 2nd sense as shown in drawing 16 (b) on the other hand when the sense of an acceleration wave is contrary to a forward wave (step 115).

[0087] (Posture judging processing of the body motion detection equipment in three-dimension

space) Although posture judging processing of the body motion detection equipment 100 in this operation gestalt is as having mentioned above, the posture judging in three-dimension space is explained to a detail by the following.

[0088] In order to detect the acceleration of the direction which intersects perpendicularly mutually, three body motion sensors a (122), the body motion sensor b (123), and the body motion sensor c (124) are formed in body motion detection equipment. The body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) have the same configuration as the body motion sensor 11 which each explained in the 1st operation gestalt. Let the condition that the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) have been arranged as shown in drawing 20 (a) be a criteria posture. At this time, three shafts of X, Y, and Z are defined as the X-axis prolonged in the method of the space (vertical plane) right, the Y-axis prolonged in the space upper part, and the Z-axis extended from the back side of the rectangular direction in space at a near side. In the criteria posture, Sensor a (122) is arranged along with the X-axis so that weight may serve as the direction of +X, Sensor b (123) is arranged along with a Y-axis so that weight may serve as the direction of +Y, and Sensor c (124) is arranged towards the direction where weight makes the direction of +X, the direction of +Y, and the include angle of 45 degrees. As for Sensor a (122), in Y shaft orientations and Sensor b (123), with this criteria posture, X shaft orientations and Sensor c (124) detect the acceleration of Z shaft orientations, respectively. moreover, this time -- the detection section of Sensor b (123) is arranged at the direction side of +X, and the detection section of Sensor c (124) is arranged for the detection section of Sensor a (122) at + Z direction side at the direction side of +Y, respectively. If it is body motion detection equipment of a configuration as shown in drawing 3 (a) or (b), the condition of having been arranged so that the upright flat field may become parallel to XY flat surface can be made into a criteria posture. In the case of drawing 20 (a), arrangement of a body motion sensor in case body motion detection equipment is a criteria posture is not restricted. For example, as shown in drawing 20 (b), Sensor a (122) is arranged so that the detection section may be located in the direction side of -Y, while meeting the X-axis so that weight may serve as the direction of +X. Sensor b (123) is arranged so that the detection section may be located in the direction side of +X, while meeting a Y-axis so that weight may serve as the direction of -Y. Weights are the direction of -X, the direction of -Y, and the direction that makes the include angle of 45 degrees, and Sensor c (124) can also be arranged so that the detection section may be located in - Z direction side. Moreover, as shown in drawing 20 (c), Sensor a (122) is arranged so that the detection section may be located in the direction side of +X, while meeting a Y-axis so that weight may serve as the direction of -Y. While meeting the X-axis so that weight may serve as the direction of +X, Sensor b (123) is arranged so that the detection section may be located in the direction side of -Y, and weights are the direction of -X, the direction of -Y, and the direction that makes the include angle of 45 degrees, and Sensor c (124) can also be arranged so that the detection section may be located in the direction of -Y.

[0089] Drawing 21 (a) shows the condition that body motion detection equipment has body motion detection equipment in a criteria posture. A rectangular parallelepiped shows the posture of body motion detection equipment typically. At this time, the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) are arranged, as shown in drawing 20 (a), respectively. The acceleration wave outputted from the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) when a user performs predetermined movement in the condition of having been held at the user so that it might become the criteria posture shown in drawing 21 (a) is shown in drawing 21 R> 1 (b).

[0090] Posture judging processing when an acceleration wave as a user indicated to be to drawing 22 R> 2 (a) by the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) in the condition of equipping with or carrying body motion detection equipment freely is outputted is explained.

[0091] First, pattern matching of the wave of drawing 22 (a) and the wave of drawing 21 (b) is performed as a pattern analysis to the output of the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124). The acceleration wave of the sensor a (122) shown in drawing 22 (a) is the reverse pattern of an acceleration wave of the sensor a (122)

shown in drawing 21 (b). Moreover, the acceleration wave of the sensor b (123) shown in drawing 22 (a) is the same pattern as the acceleration wave of the sensor b (123) shown in drawing 21 (b). And the acceleration wave of the sensor c (124) shown in drawing 22 (a) is the reverse pattern of an acceleration wave of the sensor c (124) shown in drawing 21 (b). therefore, from the pattern analysis to the acceleration wave outputted from the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) It turns out that the posture of body motion detection equipment in case the acceleration wave shown in drawing 22 (a) is outputted is in the condition of having turned the upper and lower sides over, maintaining at the surroundings of the X-axis the condition rotated 180 degrees, i.e., right and left, as shown in drawing 22 (a) from the condition shown in drawing 21 (a).

[0092] Posture judging processing when an acceleration wave as similarly a user indicated to be to drawing 23 (a) by the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) in the condition of equipping with or carrying body motion detection equipment freely is outputted is explained.

[0093] Pattern matching of the wave of drawing 23 (a) and the wave of drawing 21 (b) is performed as a pattern analysis to the output of the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124). The acceleration wave of the sensor a (122) shown in drawing 23 (a) is a pattern like the acceleration wave of the sensor b (123) shown in drawing 21 (b). Moreover, the acceleration wave of the sensor b (123) shown in drawing 23 (a) is the acceleration wave of Sensor a (122) and reverse pattern which are shown in drawing 21 (b). And the acceleration wave of the sensor c (124) shown in drawing 23 (a) is the same pattern as the acceleration wave of the sensor c (124) shown in drawing 21 (b). therefore, from the pattern analysis to the acceleration wave outputted from the body motion sensor a (122), the body motion sensor b (123), and the body motion sensor c (124) The condition which shows the posture of body motion detection equipment in case the acceleration wave shown in drawing 23 (a) is outputted in drawing 21 (a) shows that it will have been in the condition rotated -90 degrees around the Z-axis, i.e., the condition of having made it rotating rightward 90 degrees and having replaced every direction, as shown in drawing 22 (a).

[0094] Thus, by data processing to the output wave of two or more body motion sensors, the posture of body motion detection equipment can be judged and body motion detection processing of a walk mode etc. can be performed according to the specified posture. Therefore, since a user can perform body motion detection in the condition of having not fixed, and having carried or equipped with equipment freely with the predetermined posture, a user's degree of freedom spreads.

[0095]

[Effect of the Invention] As mentioned above, since the body motion sensor by which the user was suitable for body motion detection irrespective of the posture of equipment in the body motion detection equipment which can be equipped with or carried freely according to this invention can be chosen as explained, and a body motion can be detected based on the output signal of the sensor, a body motion is detectable in a high precision. Moreover, since the body motion sensor suitable for body motion detection is chosen by data processing to the output signal of two or more body motion sensors, it is not necessary to establish means, such as an angle sensor, separately, and the body motion detection equipment which can be constituted in low cost and a compact can be offered. Moreover, since it is not necessary to fix and equip a predetermined posture with equipment for body motion detection, a user's degree of freedom spreads.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the body motion detection equipment which measures by choosing the sensor suitable for measurement from two or more sensors, when two or more sensors which output the signal according to a body motion are formed.

PRIOR ART

[Description of the Prior Art] Conventionally, as body motion detection equipment which chooses from two or more sensors the output signal (or sensor) made into the object of this measurement, there are some which choose one of the output signals of two or more sensors based on the output signal of the mechanism-type include-angle detection sensor like a photo sensor about the output signal of two or more sensors, for example like the pedometer indicated by JP,9-223214,A.

[0003] Moreover, when the wearing direction of equipment is known beforehand, the body motion detection equipment which chooses from two or more sensors the sensor made into the object of this measurement is indicated by JP,11-42220,A.

[0004] moreover, the accelerometer which measures a body motion, using the acceleration sensor of biaxial or three shafts as body motion detection equipment used fixing to the direction and location which were defined beforehand, and identifies walk gestalten, such as the Taira standpoint line, stairway going up, and stairway going down, -- the 11th -- it is indicated by time living body and physiology engineering symposium collected-works BPES'96p.p493-496. The acceleration wave acquired by this report when fixed wearing is carried out and you walk along the acceleration sensor of three shafts on a candidate's lumbar part is analyzed, the walk gestalt is identified, and an accelerometer needs to carry out fixed wearing so that it may not incline to the lumbar part.

EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, since the body motion sensor by which the user was suitable for body motion detection irrespective of the posture of equipment in the body motion detection equipment which can be equipped with or carried freely according to this invention can be chosen as explained, and a body motion can be detected based on the output signal of the sensor, a body motion is detectable in a high precision. Moreover, since the body motion sensor suitable for body motion detection is chosen by data processing to the output signal of two or more body motion sensors, it is not necessary to establish means, such as an angle sensor, separately, and the body motion detection equipment which can be constituted in low cost and a compact can be offered. Moreover, since it is not necessary to fix and equip a predetermined posture with equipment for body motion detection, a user's degree of freedom spreads.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when the detecting element of mechanism types, such as an include-angle detection sensor, was prepared and an output signal was chosen, while the include-angle detection sensor needed to be formed and cost became high separately, there was a problem that equipment became large by the installation tooth space of an include-angle detection sensor.

[0006] Moreover, when the wearing direction of equipment is decided, it will have to be used having to fix the direction of equipment and the case where it can equip will be restricted. Furthermore, the stowed position of equipment was also restricted, and when the wearing direction was mistaken, there were problems -- a right measurement result is not obtained.

[0007] A user can detect a body motion in a precision high irrespective of the posture of equipment in the body motion detection equipment which can be equipped with or carried freely, and this invention has him in offering the body motion detection equipment which can be constituted in low cost and a compact, in order to solve the technical problem of this conventional technique.

MEANS

[Means for Solving the Problem] Two or more body motion sensors which this invention is equipment with which a user carries or equips freely and detects a body motion, and it is arranged so that the directions of a body motion detected, respectively may differ, and output the signal according to a body motion in order to attain the above-mentioned purpose, It is body motion detection equipment characterized by having a sensor selection means to choose whether it considers as the object of body motion detection of the output signal from which body motion sensor among said two or more body motion sensors by data processing to the output signal from said two or more body motion sensors.

[0009] If it does in this way, since a user can choose the body motion sensor which always fitted body motion detection irrespective of the posture of equipment in the body motion detection equipment with which it can carry or equip freely and can detect a body motion based on the output signal of the sensor, a body motion is detectable in a high precision. Moreover, since the body motion sensor suitable for body motion detection is chosen by data processing to the output signal of two or more body motion sensors, it is not necessary to establish means, such as an angle sensor, separately, and the body motion detection equipment which can be constituted in low cost and a compact can be offered.

[0010] Moreover, it is suitable for said sensor selection means to include a signal wave form analysis means to analyze the output signal wave from said body motion sensor.

[0011] moreover, the frequency analysis of calculation of a number of a signal wave form of counting with which said signal wave form analysis means fills the predetermined conditions acquired in fixed time amount, and the magnitude of a signal wave form, and a signal wave form and the pattern analysis of a signal wave form -- it may be made to perform either at least.

[0012] Moreover, it is suitable for said body motion sensor to output the signal which changes according to the acceleration produced by the body motion.

[0013] Moreover, the thing of a walk and transit which the body motion detected by said body motion sensor includes for either at least is suitable.

[0014] Moreover, two or more body motion sensors which this invention is equipment with which a user carries or equips freely and detects a body motion, are arranged so that the directions of a body motion detected, respectively may differ, and output the signal according to a body motion, A posture judging means to judge the posture of said equipment based on the output signal of two or more of said body motion sensors, It is characterized by having a body motion detection means to detect a user's body motion by performing data processing according to the posture of said equipment judged by said posture judging means to the output signal of two or more of said body motion sensors.

[0015] If it does in this way, since a user can carry or equip freely and can detect body motions, such as discernment of a walk gestalt, a user's degree of freedom spreads.

[0016]

[Embodiment of the Invention] Hereafter, this invention is explained based on the operation gestalt of illustration.

[0017] (1st operation gestalt) Drawing 1 is the appearance perspective view showing the pedometer as body motion detection equipment concerning the operation gestalt of this invention, and drawing 2 is this top view.

[0018] A pedometer 10 is a flat solid configuration and is making the configuration where the side face removed the end section of the long side of an ellipse form. Moreover, string supporter 10a which has the hole which inserts a string etc. in the other end of the long side of an ellipse form projects, and is formed. The display screen 2 which consists of LCD etc., a configuration switch 3, memory / ** switch 4, the display change-over switch 5, and the reset switch 6 are formed in the front face of a case 1. The cell covering 7 and the system-reset switch 8 are formed in the rear face of a case 1.

[0019] Assignment of a stowed position is made by an operation manual etc. as there is a posture generally recommended in a pedometer, for example, the lumbar part, such as a belt, pants, a skirt board, and trousers, is certainly equipped with a clip. Even when a pedometer is held with the posture always recommended like [when putting in into a pocket or putting in into

********** or a bag from the neck] on the other hand, in this pedometer 10, highly precise counting is possible.
[0020] Drawing 3 shows typically arrangement of the body motion sensor inside [case 1] a pedometer (however, other configurations within cases, such as the circuit board, are omitted.).
[0021] The body motion sensor used with this operation gestalt is an acceleration sensor which outputs the signal which changes according to the acceleration produced by the body motion. Including tabular base material 11a, weight 11b prepared in the base material edge, and detection section 11c which consists of a piezoelectric device formed on the base material side, the body motion sensor 11 (other body motion sensor 12 grades are the same) changes into the voltage signal of piezoelectric-device 11c deformation (distortion) of base material 11a produced with the acceleration which originates in a body motion and acts on weight, and takes it out.
[0022] In drawing 3 (a), the body motion sensors 11 and 12 are arranged in the XY direction which intersects perpendicularly mutually. Three or more body motion sensors may be arranged like drawing 3 (b). In addition to the body motion sensor 111,112 of the XY direction which intersects perpendicularly mutually, in drawing 3 (b), one body motion sensor 113 and the body motion sensor 114 which detects the body motion of the Z direction which intersects perpendicularly further at the flat surface at which three body motion sensors 111,112,113 have been arranged are arranged in about 45-degree direction across which it faces in the XY direction. Since any output of the body motion sensor 111,112 becomes small about a body motion with an include angle of about 45 degrees inserted in the XY direction, in such a case, the body motion sensor 113 is effective.
[0023] Drawing 4 is the block diagram showing the internal configuration of a pedometer 10.
[0024] The body motion sensors 11 and 12 for body motion detection arranged in the XY direction in which a pedometer 10 mainly intersects perpendicularly mutually, The amplifying circuits 13 and 14 which amplify the output voltage of the body motion sensors 11 and 12, a cell 19, and time of day and the number of steps - continuation -- the number of steps -- with LCD2 which displays - continuation walk time amount and a consumption calorie It consists of an arithmetic circuit 15 which controls the actuation switch 17, the system-reset switch 8, a LCD display control and actuation switch input detection, sequence control, current supply, etc. of configuration-switch 3 grade.
[0025] The signal acquired from the body motion sensors 11 and 12 is inputted into the operation shaft judging section 21. the signal of the operation shaft with which the operation shaft was chosen and chosen in the operation shaft judging section 21 -- using -- the number of steps -- the number of steps is counted with a counter 23.
[0026] Drawing 5 is the block diagram of the pedometer which has four body motion sensors as shown in drawing 3 (b). Since it has the same configuration as the pedometer shown in drawing 4 except for the point that a total of four amplifying circuits are prepared for every body motion sensor, detailed explanation is omitted. With the body motion detection equipment concerning this invention, the number of a body motion sensor is not restricted to an above-mentioned thing.
[0027] (The number processing of pedometers) Below, the number processing of pedometers in which the pedometer was used is explained.
[0028] Drawing 6 is a flow chart which shows the procedure of the main routine of the number processing of pedometers in a pedometer.
[0029] First, processing is started by the input of the output signal from a body motion sensor.
[0030] Operation shaft judging processing is performed based on the output from the amplifying circuit connected to two or more body motion sensors inputted into the operation shaft judging section (step 1). It is fixed to a specific operation shaft by judgment processing of an operation shaft (step 2). next, the output data from the body motion sensor corresponding to the fixed operation shaft -- the number of steps from a buffer -- counting of delivery and the number of steps is carried out to a counter (step 3). The data of a buffer are eliminated in connection with this (step 4). next, the number of steps -- the number of steps by which counting was carried out with the counter is displayed on LCD (step 5). At this time, the number of steps of the walk detected by the body motion sensor corresponding to an above-mentioned operation shaft is displayed on LCD. Next, it judges whether the wave of one step was inputted (step 6). If step 6 is

repeated and the wave of one step is inputted until the wave of one step is inputted, it will judge whether it was inputted within 2 seconds (step 7). if it is less than 2 seconds -- the number of steps -- the count of a counter is carried out +one (step 8), and it returns to step 5. If it is not less than 2 seconds, it will return to step 1.

[0031] (Operation shaft judging processing) First, an acceleration sensor constitutes a body motion sensor and the case where operation shaft judging processing is performed using the number of acceleration waves obtained in fixed time amount as analysis of an acceleration wave obtained at the time of a walk is explained.

[0032] Drawing 7 is a flow chart which shows the procedure of operation shaft judging processing.

[0033] First, an operation shaft judging timer is started (step 11).

[0034] Next, wave processing of the body motion sensor 1 is performed (step 12), and wave processing of the body motion sensor 2 is performed (step 13).

[0035] Here, the example of an acceleration wave acquired by the body motion sensor 1 and the body motion sensor 2 is shown in drawing 8 . In drawing 8 , an axis of abscissa is time amount (sense to which time amount progresses [the method of the right]), and an axis of ordinate is acceleration (for example, expressed and carried out by the electrical potential difference.).

[0036] Next, it judges whether the time check of an operation shaft judging timer has passed 4 seconds (step 14). If 4 seconds have not passed, it returns to step 12. The number of acceleration waves obtained from the output signal of the body motion sensor 1 stored in the buffer 1 when 4 seconds had passed, For example, the number of acceleration waves obtained at the time of a walk (in the flow chart, this is written as "the buffer 1".) The number of acceleration waves obtained from the output signal of the body motion sensor 2 stored in the buffer 2 (in the flow chart, this is written as "the buffer 2".) It judges whether it has a relation that it is large or equal (step 15). When the relation that it is larger than the number of acceleration waves obtained from the output signal of the body motion sensor 2 by which the number of acceleration waves obtained from the output signal of the body motion sensor 1 stored in the buffer 1 is stored in the buffer 2, or equal is realized, the body motion sensor 1 is chosen as an operation shaft (step 16), and operation shaft judging processing is ended. When the relation that it is larger than the number of acceleration waves obtained from the output signal of the body motion sensor 2 by which the number of acceleration waves obtained from the output signal of the body motion sensor 1 stored in the buffer 1 is stored in the buffer 2, or equal is not realized, the body motion sensor 2 is chosen as an operation shaft (step 17), and operation shaft judging processing is ended. That is, the direction with many acceleration waves is chosen as an operation shaft.

[0037] (Wave processing) Drawing 9 (a) is a flow chart which shows the procedure of wave processing of the body motion sensor 1.

[0038] It judges whether the acceleration wave acquired from the output signal of the body motion sensor 1 is already over the upper threshold with a flag (Thu1) (step 21). If it is Thu 1= 0, if a judgment is repeated (step 22) and an upper threshold is exceeded until it exceeds an upper threshold, a flag (Thu1) will be set to 1 (step 23), and it will progress to the judgment of a bottom threshold. On the other hand, if it is Thu 1= 1, it will progress to the judgment of a bottom threshold. Here, the judgment of whether the acceleration wave acquired from the output signal of the body motion sensor 1 exceeded the bottom threshold is repeated until an acceleration wave exceeds a bottom threshold (step 24), and if a bottom threshold is exceeded, an acceleration wave will judge whether it is 1 wave eye (step 25). For example, if it is the acceleration wave acquired at the time of a walk, 1 will be added to the value with which 1 wave eye was unconditionally stored in the buffer (step 27), and if it is after 2 wave eye It judges whether spacing with 1 wave front is in convention spacing (Ts default value min<= Ts and Ts<= Ts default value max) (step 26), and if it is in convention spacing, 1 will be added to the value stored in the buffer (step 27). Then, a flag is set to 0 (Thu1) (step 28), and it is repeated until an axial judgment timer passes for 4 seconds. Although drawing 8 (b) is a flow chart which shows the procedure of wave processing of the body motion sensor 2, since the detail of processing is the same as that of drawing 8 (a), explanation is omitted. The judgment performed at step 26 is the meaning which eliminates signals other than the signal by walk from the output signal of a body motion sensor.

[0039] Thus, since the output of a body motion sensor suitable in software is taken out and

counting, such as the number of steps, is performed, without establishing separately the posture detection means of equipments, such as an angle sensor of a mechanism type, the tooth space and cost for a posture detection means become unnecessary. Therefore, low cost and a compact pedometer can be constituted.

[0040] in addition, the equipment which detects and uses a body motion although this operation gestalt explains only the pedometer as body motion detection equipment -- it is -- ****ing -- the number of steps -- naturally what is changed into the index of an except is contained.

[0041] (2nd operation gestalt) The 2nd operation gestalt of this invention is explained hereafter. Since it is the same as that of the 1st operation gestalt about the internal configuration of a pedometer, and the number processing of pedometers, only a different part is explained.

[0042] With this operation gestalt, operation shaft judging processing is performed using the power value of an acceleration wave as analysis of an acceleration wave obtained at the time of a walk.

[0043] (Operation shaft judging) Drawing 10 is a flow chart which shows the procedure of operation shaft judging processing.

[0044] Since the processing to step 41 - step 44 is the same as that of the case where the number of acceleration waves shown in drawing 7 is used, explanation is omitted.

[0045] The power value of an acceleration wave acquired from the body motion sensor 1 and the body motion sensor 2 when the operation shaft judging timer passed for 4 seconds (the square of a peak-to-peak value (maximum among the algebraic difference between the extremal value of the acceleration wave within the predetermined section) defines.), For example, the aggregate value (Pp(1)2+Pp(2)2+Pp(3) 2) (in drawing 9 , it is written as Pp1 and Pp2) of the power value (2) of 3 waves of the beginning of the waves acquired in 4 seconds is compared (step 45). The one where the aggregate value of a power value is larger is chosen as an operation shaft as a result of a comparison (steps 46 and 47). Moreover, the magnitude of the absolute value of p-p may compare.

[0046] (Wave processing) Drawing 11 (a) is a flow chart which shows the procedure of wave processing of the body motion sensor 1.

[0047] First, it is the flow chart which shows the procedure of wave processing of the body motion sensor 1.

[0048] It judges whether the acceleration wave acquired from the output signal of the body motion sensor 1 is already over the upper threshold with a flag (Thu1) (step 51). If it is Thu 1= 0, if a judgment is repeated (step 52) and an upper threshold is exceeded until it exceeds an upper threshold, a flag (Thu1) will be set to 1 (step 53), and it will judge whether it is 1 wave eye (step 54). Here, if it is 1 wave eye, it will progress to the judgment of the bottom threshold of step 59, and if it is after 2 wave eye, it will judge whether spacing (Ts) with 1 wave front is in convention spacing (Ts default value min<= Ts and Ts<= Ts default value max) (step 55). If Ts is convention within the limits, 1 is added to the value stored in the buffer (step 56), and the power value (2) of an acceleration wave will be computed and it will add to the power value of a prewave form (step 57). For example, only the first 3 waves acquired in 4 seconds are added to Pp1 (step 57). On the other hand, when it is Thu 1= 1 in step 53, or as well as the case where a power value is added when it is 1 wave eye in step 54, it progresses to the judgment of a bottom threshold. Here, the judgment of whether the acceleration wave acquired from the output signal of the body motion sensor 1 exceeded the bottom threshold is repeated until an acceleration wave exceeds a bottom threshold (step 59), and it is repeated until it will set a flag to 0 (Thu1) (step 60) and an axial judgment timer will pass for 4 seconds, if a bottom threshold is exceeded. Although drawing 11 (b) is a flow chart which shows the procedure of wave processing of the body motion sensor 2, since the detail of processing is the same as that of drawing 11 (a), explanation is omitted.

[0049] Although addition of a power value was made into the first aggregate value of 3 waves acquired in 4 seconds in above-mentioned processing, 2 waves or three waves or more are sufficient. Moreover, it is not necessary to use it from 1 wave eye.

[0050] (3rd operation gestalt) The 3rd operation gestalt of this invention is explained hereafter. Since it is the same as that of the 1st operation gestalt about the internal configuration of a pedometer, and the number processing of pedometers, only a different part is explained.

[0051] With this operation gestalt, operation shaft judging processing is performed using the frequency analysis of an acceleration wave as analysis of an acceleration wave obtained at the time of a walk.
[0052] (Operation shaft judging processing) Drawing 12 is a flow chart which shows the procedure of operation shaft judging processing.
[0053] First, an operation shaft judging timer is started (step 71).
[0054] Next, the Fourier transform of the acceleration wave acquired by the body motion sensor 1 is carried out (step 72), and the Fourier transform of the acceleration wave acquired by the body motion sensor 2 is carried out (step 73).
[0055] The example of the frequency distribution acquired by drawing 13 (a) and (b) by carrying out the Fourier transform of the acceleration wave acquired by the body motion sensor 1 and the body motion sensor 2, respectively is shown. As shown in drawing 13 (a), there is nothing, for example, a high peak (height F1max) is seen in the location (F1) which dispersion likes extremely as for frequency distribution of the body motion sensor 1 of an acceleration wave and which is 2Hz. As shown in drawing 13 (b), frequency distribution of the body motion sensor 2 of an acceleration wave varies, a low peak (height F2max) is in the location (F2) of 2.1Hz, and a lower peak exists in other frequencies. As for this example, the condition that the signal which the acceleration change by the body motion which should be detected in body motion sensor 1 direction is detected, and includes an unnecessary vibration from which the body motion which should be detected in a body motion sensor 2-way differs is detected is shown.
[0056] Next, an operation shaft judging timer repeats steps 72 and 73, for example until it judges whether 4 seconds passed (step 74) and passes 4 seconds in it.
[0057] When the time check of an operation shaft judging timer passes 4 seconds, the value (all encompassing of an F1max= power value) of a frequency (F1) with the analysis result of an acceleration wave obtained from the body motion sensor 1 and the maximum peak and the maximum peak is detected (steps 75 and 76). Next, F1 judges whether it is the inside of a convention frequency range (step 77), and if it is outside a convention frequency range, the zero clear of the F1max will be carried out (step 78). Here, normal frequency is set to 1Hz - 3Hz, for example. The value (all encompassing of an F2max= power value) of a frequency (F2) with the analysis result of an acceleration wave similarly obtained from the body motion sensor 2 and the maximum peak and the maximum peak is detected (steps 79 and 80), and F2 judges whether it is the inside of a convention frequency range (step 81). If F2 is in a convention frequency range, F1max will judge whether it is 0 (step 82). At this time, if F1max becomes zero, the body motion sensor 2 will be chosen as an operation shaft (step 85). On the other hand, if F1max is not 0, it will judge whether it is F1 max>=F2max (step 83). Here, if it becomes F1 max>=F2max, the body motion sensor 1 will be chosen as an operation shaft (step 84). Moreover, if stepF2 is outside a convention frequency range in 81, F1max will judge whether it is 0 (step 86). Here, if it is not F1max=0, the body motion sensor 1 will be chosen as an operation shaft (step 84). If it is F1max=0, the zero clear of the axial judgment timer will be carried out (step 87), and it returns to step 71, and an operation shaft judging is performed again.
[0058] (4th operation gestalt) The 4th operation gestalt of this invention is explained hereafter. Since it is the same as that of the 1st operation gestalt about the internal configuration of a pedometer, and the number processing of pedometers, only a different part is explained.
[0059] With this operation gestalt, operation shaft judging processing is performed using the pattern analysis of an acceleration wave as analysis of an acceleration wave obtained at the time of a walk.
[0060] (Operation shaft judging processing) Drawing 14 is a flow chart which shows the procedure of operation shaft judging processing.
[0061] First, an operation shaft judging timer is started (step 91). Next, the acceleration wave acquired from the body motion sensor 1 and the body motion sensor 2 is compared with a reference waveform (steps 92 and 93). For example, it asks for the reference waveform from the data collected beforehand, and it compares with the wave detected at the time of measurement. An operation shaft judging timer repeats steps 92 and 93, for example until it passes for 5 seconds (step 94). If 5 seconds of a time check of an operation shaft judging timer pass, an

operation shaft will be chosen by the pattern-analysis result of an acceleration wave obtained in 5 seconds. Here, it judges whether the acceleration wave [error / with a reference waveform] from the body motion sensor 1 is larger (step 95). If the acceleration wave [error / with a reference waveform] from the body motion sensor 1 is larger, the body motion sensor 2 will be chosen as an operation shaft (step 97), and if equal or the acceleration wave [error / with a reference waveform] from the body motion sensor 1 is smaller, the body motion sensor 1 will be chosen as an operation shaft (step 96).

[0062] As an above-mentioned pattern analysis of an acceleration wave, you may compare with the reference waveform beforehand called for using the peak value of an acceleration wave, wave-like width of face, peak spacing (period), the crest in 1 wave, the number of troughs, etc., the stability of the appearance of a detection wave using said parameter may be used, and the wave-like pattern analysis using a cluster-analysis method etc. may be used, for example.

[0063] (5th operation gestalt) The pedometer as body motion detection equipment which has a different body motion sensor from the above-mentioned operation gestalt as 5th operation gestalt is explained. Since the configuration of those other than a body motion sensor is the same as that of the 1st thru/or 4th operation gestalt, explanation is omitted.

[0064] Drawing 15 (a) shows the body motion sensor 120 used for the body motion detection equipment concerning this operation gestalt.

[0065] It is the acceleration sensor which outputs the signal with which the body motion sensor 120 also changes according to the acceleration produced by the body motion. The body motion sensor 120 contains reed switch 120c which rocks the supporting point as a core, is prepared in the predetermined location near the rocking range of pendulum 120a by which it was equipped with magnet 120b at the tip, and pendulum 120a, becomes ON by contiguity of magnet 120b, and becomes off by alienation. The rocking range of a pendulum is regulated by the non-illustrated stopper. Moreover, pendulum 120a is constituted so that the pendulum rocked with energization means, such as a vine firewood spring, may return to a predetermined location. Pendulum 120a rocked with the acceleration which originates in a body motion and acts on a pendulum, and rocking of this pendulum 120a is changed and taken out to change of the electrical potential difference or current produced by 120c closing motion of the reed switch by contiguity of magnet 120b.

[0066] The output signal of the body motion sensor 120 serves as pulse shape, as shown in drawing 15 (b). Although the spacing Ts between pulses (1) is similarly defined as the acceleration wave shown in drawing 8 , pulse width is defined as Pp (1) here. By the body motion sensor 120, since, as for the magnitude of the acceleration by the body motion, the rocking include angle of pendulum 120a becomes large and the time amount to which magnet 120b is close to reed switch 120c becomes long, pulse width becomes large. For this reason, pulse width is defined as Pp.

[0067] The operation shaft judging processing in the 1st operation gestalt is applicable also to the body motion sensor concerning this operation gestalt by making the number of acceleration waves into the number of pulse shape.

[0068] Moreover, the operation shaft judging in the 2nd operation gestalt is applicable also to the body motion sensor concerning this operation gestalt by defining Pp as mentioned above.

[0069] Moreover, since the operation shaft judging processing in the 3rd and 4th operation gestalten can perform same analysis processing also with pulse shape, it is applicable also to the body motion sensor concerning this operation gestalt.

[0070] Although the above-mentioned body motion sensor 120 has detected rocking of a pendulum with the combination of a magnet and a lead sensor, the tip of a pendulum may form a photo interrupter, and may not be intermittent in an optical path with rocking of a pendulum, and it is not restricted to these configurations.

[0071] (6th operation gestalt) The body motion detection equipment concerning the 6th operation gestalt of this invention is explained hereafter. With the output of a body motion sensor, the body motion detection equipment concerning this operation gestalt judges the posture of the body motion detection equipment freely carried or carried by the user, and, in addition to counting of the number of steps, or this, identifies walk gestalten, such as the Taira standpoint line,

stairway going up, and stairway going down, based on the posture.
[0072] First, the principle which judges the posture of body motion detection equipment is explained.
[0073] In drawing 16 , it explains using the body motion sensor 11 concerning the pedometer concerning the 1st operation gestalt, and the body motion sensor which has the same configuration. About a sign, the same sign as the body motion sensor 11 is used. The body motion sensor 11 is an acceleration sensor which outputs the signal which changes according to the acceleration which is equipped with detection section 11c which consists of a piezoelectric device formed on one field of tabular base material 11a, and weight 11b formed in the edge, and is produced by the body motion.
[0074] The condition that detection section 11c is located in the top face of base material 11a in the condition that detection section 11c is located in the inferior surface of tongue of base material 11a about direction of the body motion sensor 11 as shown in drawing 16 (a) as shown in the 1st sense and drawing 16 (b) is defined as the 2nd sense. the case where movement of the direction of an arrow head produces the wave displayed on the right-hand side of the body motion sensor 11 of drawing 16 (a) and (b) here -- (-- the sense of movement is the same irrespective of the sense of a body motion sensor.) -- the acceleration wave outputted from the body motion sensor 11, respectively is shown. Since the methods of the deformation produced in a piezoelectric device differ according to whether detection section 11c is formed on which [of base material 11a] field even when the same movement arises, the waves outputted also differ. Therefore, if the acceleration wave outputted from the body motion sensor 11 arranged at the 1st sense shown in drawing 16 R> 6 (a) is made into a forward wave, from the body motion sensor 11 arranged at the 2nd sense shown in drawing 16 (b), the reversed acceleration wave (cross-sea form) will be outputted.
[0075] Therefore, if the pattern of an acceleration wave by various movements in the case of taking the posture in which body motion detection equipment (or body motion sensor) serves as criteria to a user or space is memorized beforehand, it will become possible to judge the posture of body motion detection equipment by comparing with the pattern of an acceleration wave at the time of a criteria posture the pattern of an acceleration wave outputted from a body motion sensor. That is, the posture of body motion detection equipment can be judged in software by data processing to the output signal from a body motion sensor, without having mechanism-equipment for a special posture judging.
[0076] The block diagram of the body motion detection equipment 100 applied to this operation gestalt at drawing 17 is shown. About the same configuration as the 1st operation gestalt, explanation is omitted using the same sign.
[0077] The signal acquired from the body motion sensors 111-114 with this operation gestalt is the posture judging section.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the appearance perspective view of the pedometer concerning the operation gestalt of this invention.
[Drawing 2] Drawing 2 is the top view of the pedometer concerning the operation gestalt of this invention.
[Drawing 3] Drawing 3 is drawing showing arrangement of the body motion sensor in a pedometer.
[Drawing 4] Drawing 4 is the block diagram showing the internal configuration of a pedometer.
[Drawing 5] Drawing 5 is the block diagram of other pedometers.
[Drawing 6] Drawing 6 is a flow chart which shows the procedure of the number processing of pedometers in a pedometer.
[Drawing 7] Drawing 7 is a flow chart which shows the procedure of operation shaft judging processing.
[Drawing 8] Drawing 8 is drawing showing the example of an acceleration wave acquired by the

body motion sensor.
[Drawing 9] Drawing 9 is a flow chart which shows wave processing of a body motion sensor.
[Drawing 10] Drawing 10 is a flow chart which shows the procedure of operation shaft judging processing.
[Drawing 11] Drawing 11 is a flow chart which shows other wave processings of a body motion sensor.
[Drawing 12] Drawing 12 is a flow chart which shows the procedure of other operation shaft judging processings.
[Drawing 13] Drawing 13 is drawing showing the result of having carried out the Fourier transform of the acceleration wave of a body motion sensor.
[Drawing 14] Drawing 14 is a flow chart which shows the procedure of other operation shaft judging processings.
[Drawing 15] The configuration of the drawing 15 (a) body motion sensor is shown typically. Drawing 15 (b) is drawing showing the output signal of a body motion sensor.
[Drawing 16] Drawing 16 (a) and (b) are drawings explaining the posture judging principle of body motion detection equipment.
[Drawing 17] Drawing 17 is the block diagram showing the configuration of the body motion detection equipment concerning the 6th operation gestalt of this invention.
[Drawing 18] Drawing 18 is a flow chart which shows the main procedure of the body motion detection processing in the body motion detection equipment concerning the 6th operation gestalt of this invention.
[Drawing 19] Drawing 19 is a flow chart which shows the procedure of the posture judging processing in the body motion detection equipment concerning the 6th operation gestalt of this invention.
[Drawing 20] Drawing 20 (a), (b), and (c) are drawings showing the example of arrangement of three body motion sensors.
[Drawing 21] Drawing 21 (a) is drawing showing the body motion detection equipment in a criteria posture, and drawing 21 (b) is a graph which shows the output wave from each body motion sensor at the time of a criteria posture.
[Drawing 22] Drawing 22 (a) is drawing showing the body motion detection equipment in other postures, and drawing 22 (b) is a graph which shows the output wave from each body motion sensor at the time of other postures.
[Drawing 23] Drawing 23 (a) is drawing showing the body motion detection equipment in the posture of further others, and drawing 23 (b) is a graph which shows the output wave from each body motion sensor at the time of the posture of further others.
[Description of Notations]
1 Case
2 LCD
3 Configuration Switch
4 Memory / ** Switch
5 Display Circuit Changing Switch
6 Reset Button
10 Pedometer
11 12 Body motion sensor
111,112,113,114 Body motion sensor
100 Body Motion Detection Equipment
121 Posture Judging Section
122 Body Motion Sensor A
123 Body Motion Sensor B
124 Body Motion Sensor C

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